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PLANNING AND PUBLIC UNDERSTANDING

AT a conference in London of representatives of local authorities, organized by the Town and Country Planning Association, both Mr. G. S. Lindgren, then Parliamentary Secretary to the Ministry of Town and Country Planning, and Lord Silkin emphasized the need for securing public understanding of plans for development. Planning authorities, urged Lord Silkin, should not give decisions without explaining them in language that the public can understand. Lord Silkin admitted that the Ministry had not been free from blame in this respect, and it would be true to say that where bitterness has crept into this field it has almost invariably been due to a Ministry or government department both judging its own cause and failing to give any reasonable explanation of its decision to those affected.

If, as Sir George Pepler suggested at the same conference, town and country planning should be the servant of public opinion, the Ministries themselves and the Service Departments have still much to learn. Public opinion, however, must be informed, and though this is in part a task of the Ministry of Local Government and Planning, it is one that must be shared by other bodies also. Indeed, the general neglect by the present Government of the responsibility for seeing that public understanding and support for legislative or administrative action is secured so far as possible suggests that the Government is likely to prune even further its meagre efforts of this sort, and that increasing reliance must in future be placed on private or independent effort.

In such circumstances, pamphlets like that of F. B. Gillie and P. L. Hughes on "Some Principles of Land Planning"* are especially welcome. The authors are, in fact, officials of the Ministry ; but their exposition of the issues underlying the problems that technical specialists in land planning are called upon to solve expresses their own views and not necessarily those of their department. Nevertheless, it represents just that type of approach to the layman which Ministries should be making, and in its exposition of basic conceptions and fundamental principles it should not only help to remove from the lay mind some of the confusion and misunderstanding of a complex subject, but also provide a stimulus to further thinking by serious students about the whole background of the subject.

The authors start by pointing out that the main principle behind the Town and Country Planning Act, 1947, does not, in strict logic, involve preparing a plan at all. The Act provides that henceforth all significant changes of land use require the permission of a public authority, which shall decide whether they are sound or not. The preparation of a plan is a natural, but not inevitable, consequence of this basic decision, the reason for which is the increasing competition for land. It has for that reason been decided that the control hitherto afforded by the

* Some Principles of Land Planning. By F. B. Gillie and P. L. Hughes. Pp. iii+91. (Liverpool : University Press of Liverpool, 1950.) 5s. net.

price mechanism or estate management policy, for example, shall be subject to one over-riding control under the Planning Acts, with the express function of resolving all conflicts over the use of land in the manner which best serves the public interest.

To resolve such conflicts is the essence of planning control, and primarily determines the form which planning control takes. Moreover, such control can never be wedded to any single interest. Its object must always be the promotion of all interests using land which are of value to society, necessarily subordinating one to another in particular circumstances, but never giving any one interest an automatic predominance.

There are three points here which require particular notice. First, as Gillie and Hughes note, a plan must show what changes in the use of land are desirable and what are not. If the planning authority fully understands what changes are critical, the forces at work, and how far they are beneficial or otherwise, the authority is equipped for the task of explaining its policy to the public and indicating to those who wish to make changes or developments the limits within which they can work. If this is properly done much time and friction will be avoided, as Gillie and Hughes, indeed themselves stress later in their pamphlet.

It is the friction which arises when the authority's plans conflict with individual proposals or projects that is responsible, as PEP pointed out in an admirable broadsheet ("Town Planning and the Public", No. 316) last year, for much of the present dissatisfaction with, or opposition to, town and country planning. There would be less obstruction or feeling of frustration if the situation were fully understood, and particularly if those affected had a reasonable opportunity of submitting alternative proposals which would not conflict with the public interest or the proposed standards. In any event, planning will fail of its full purpose unless it secures the goodwill of the public and their intelligent co-operation.

Even such an excellent exposition of principles as that produced by Gillie and Hughes cannot achieve its purpose if goodwill is undermined and destroyed. That is precisely why it is so serious that operations of the Service Departments, for example, are excluded from the Town and Country Planning Act; or again, to take a more recent example, that coal is excluded from consideration in the pamphlet on the control of mineral working which the Ministry of Town and Country Planning issued early this year. The present importance of coal supply does not justify the exemption of the Ministry of Fuel from such control or responsibility. It is the tendency to allow government departments to act as a law unto themselves and to judge their own interests that prejudices discussion of well-nigh every aspect of the utilization of land, whether it be for mineral working, for water or power supply, for building, for training purposes or for amenity. Messrs. Gillie and Hughes may well be conscious of this, though they have little to say about it, except on the vexed question of mineral working: to Service lands and hydro-electric power schemes they make no reference, nor, indeed, is the question of national parks or of nature reserves mentioned.

The third point that emerges very clearly again and again in this pamphlet is that on many of the issues requiring decision the basic information is incomplete or entirely lacking. Much of the information necessary for a better appreciation of the agricultural planning problem is at present wanting and cannot be secured quickly. So, too, in regard to mineral working, much of the factual material necessary for a realistic policy is lacking. Even the examination of the available geological material is a lengthy and expert task, and the associated engineering, transport and marketing problems have not been worked out; nor can they be cleared up quickly, because the necessary research work is laborious, and skilled research workers cannot be trained quickly.

All this may provide one explanation why local authorities are better at preventing bad development than at the more difficult and imaginative task of facilitating good development and seizing unexpected opportunities for progress. It provides, moreover, an overwhelming reason for full co-operation and consultation between all the interests concerned, and the strongest possible argument against unilateral decision by any one department, authority or interest. Even in agricultural planning, for example, the non-agricultural factors are as important as agricultural ones in assessing the merits of the proposed use; and if the defence requirements now make it unlikely that Great Britain can afford to increase the proportion of its effort devoted to research in this field, only real co-operation between the different interests offers the prospect of securing the wisest use of the nation's resources and a proper balance between long-term and short-term requirements. Apart from this, as Gillie and Hughes observe, it is part of the planner's job to gauge how far he can convert opinion to his view within the time at his disposal—an observation which could scarcely be more condemnatory of some examples of departmental practice.

There is a further factor stressed in this pamphlet which must be taken into account. It has already been suggested that the defence programme itself may make an appreciable expansion of research into planning problems impracticable for the present. In other directions also the question of staff may impose limits on the expansion of the activities of a public authority within a short period, even under normal conditions. Limitations of labour and materials also affect development.

Apart from the danger, to which the pamphlet directs attention, of premature decisions on complex matters, it must also be remembered that many of the subjects on which we require fuller knowledge before we can estimate their bearing on planning policy involve intricate research for which local planning authorities are often not equipped. The recent annual report of the Department of Scientific and Industrial Research provides an excellent illustration of this point. The Geological Survey provided by its borings the crucial evidence which determined the choice between two sites for the pro-

posed new town near Congleton in Cheshire, and its investigations of a site in the Dane valley in connexion with a proposed dam to impound water revealed the probability of serious leakage which led to the scheme being abandoned. Neither investigation could well have been undertaken by local authorities; and even if they had been so equipped, some central co-ordination would still be required to avoid waste of our limited resources for research and survey. Prof. Dudley Stamp has powerfully urged this need for unified research so as to avoid duplication of effort by different bodies; only by ensuring that there is no dissipation of research effort ineffectively among unco-ordinated research staff can we hope to acquire, in time for action, more than a fraction of the data required for wise planning. Moreover, it is equally important to ensure that when the research or survey is completed, its results are made fully available and taken into account by the central government, no less than by local authorities. To all these aspects of the problem this pamphlet directs attention, and it should make a real contribution towards securing the widespread public understanding of the issue upon which successful planning depends.

SOCIAL SCIENCE DURING THE SECOND WORLD WAR

Problems of Social Policy

By Richard M. Titmuss. (History of the Second World War: United Kingdom Civil Series.) Pp. xi+596. (London: H.M. Stationery Office, and Longmans, Green and Co., Ltd., 1950.) 25*s*.

THE social history of Great Britain during the Second World War is a subject of the greatest interest to all social scientists. An immense amount of material was assembled by government departments relating to the reactions of the ordinary citizens to dangers, deprivations and dislocations, and Prof. R. M. Titmuss's task has been to make the most significant facts, which are buried in the mass of files and reports, available to the serious student. He has now presented the information he has selected in the framework provided by the history of the War itself; the story he tells is the straightforward one of preparation for the event, the event itself and the aftermath. In this way the accuracy of the forecasts on which policies were based is assessed with judicial impartiality, the ways in which the administrative measures that were planned to deal with the various emergencies succeeded or fell short of the mark are examined, and the adaptations or improvisations that were necessitated to deal with the muddles and the disasters that the country had to face are carefully described. Finally, an attempt is made to analyse the general effect of war-time social policy on British society.

Prof. Titmuss's work is both scholarly and attractive, and as penetrating as it is comprehensive. Its fascination is such that it is almost impossible to lay it down when one has started to read it, as the great interest of the subject-matter, and the lucidity with which it is presented, grip the mind so firmly. Moreover, it serves the purpose of allaying one's curiosity about so many mysteries that puzzled one at the time. It is in this work that we find answers to the questions we have put so often before. Now we know, for example, what happened in Bootle during the heavy air attacks in 1941; why Whitehall was so slow to appreciate the importance of the social problems of evacuation; the extent to which the Emergency Medical Service succeeded in its task, and so forth and so on. We are taken behind the scenes, as it were, by one who has proved himself to be a skilled detective as well as a bold explorer.

The story that Prof. Titmuss tells is one in which the leading part is played by the ordinary citizen, putting up an incredibly good battle against heavy odds, prepared to go back to work only a few days after the total destruction of his home, and to face severe physical dangers in order to keep his family ties intact. It was his (and her) good sense and courage that held the British nation together and won the War. This simple conclusion is a magnificent justification for the social services that we have been so painstakingly building up during the past century or so, on which so much money has been spent to the alarm and despondency of so many people in recent years. The influence of these services, we now see, has not been to "undermine self-reliance", but to give the ordinary man and woman a better chance to look after himself and his family, and something of a foundation on which they can build a stronger society for themselves. The trouble has been that the social services were able to do too little, rather than that they attempted too much.

From the point of view of social policy, it was the strain of war-time administration that broke the machinery of the old poor law, and finally discredited its philosophy. The provision of the bare necessities of life to those who were 'bombed-out' plainly failed to stimulate self-reliance, and the application of complicated means-tests to a wide variety of services brought with it a correspondingly complicated administrative machine that proved to be much more trouble than it was worth. In the end, the simple beliefs of even the Treasury in the social theories of the Benthamites were shaken, and replaced by a much more positive system of ideas which had grown up around some of the newer social services developed during the present century. It was the knowledge and the skills that became available in this way that saw the country through in the end.

The social scientists, as such, played only a small part in this process of transformation and adaptation. In some respects the forecasts that they made were very wide of the mark, as, for example, in the advice which psychiatrists gave the Government on the effects of air attack on the mental health of the population. The facts were, as is now well known, that the numbers treated on this account actually fell during the War, which conflicted quite dramatically with the forecast that mental casualties might outnumber physical casualties by two or three to one. It is also disappointing to record Prof. Titmuss's criticism of the much-publicized forecasts produced in 1940, by a group of scientific workers engaged in operational research, of the effects of heavy bombing raids on Coventry. This, we now learn, was seriously defective in several respects, notably in its failure to stress the importance of house damage and the problem of homeless people.

On the other hand, social scientists had undoubtedly begun to pull their weight before the War ended. The development of the Wartime Social Survey was a notable achievement, and it is a pity that Prof. Titmuss has relegated it to three footnotes. The

flexibility of the British system of social administration gave them their chance, particularly in the handling of 'problem' children encountered by evacuation authorities. Much of the work now done by the Child Care Service is built on foundations laid at this time. It is therefore to be hoped that Prof. Titmuss will continue his task and attempt to apply the lessons he has drawn from the social history of the War to contemporary conditions.

The voluntary associations, which contributed so efficiently and perhaps even decisively to the solution of the social problems of the time, are now gravely weakened as the result of the Government's taxation policy. The structure of local government, which again contributed so much, is also seriously undermined. Are the new national agencies, such as the National Assistance Board and the Regional Hospitals Boards, able to take their place in another emergency that may arise in the near future? Are they prepared to pay adequate attention to the work of the social scientist, and place sufficient reliance on the skills of the professional social worker? Prof. Titmuss should give us an answer to this disturbing, but critically important, question. T. S. Simey

PLANT PHYSIOLOGY FOR STUDENTS

An Introduction to the Principles of Plant Physiology

By Prof. Walter Stiles. Second edition, revised. Pp. x+701+5 plates. (London: Methuen and Co., Ltd., 1950.) 60*s*. net.

FOR fourteen years the first edition of this textbook has been familiar to students all over the English-speaking world. It needs no introduction to botanists, and it is the pleasant first duty of a reviewer to welcome a second edition, and to commend it to such students as can afford to buy it, and to all who teach plant physiology, whether they can afford to buy it or not. For Prof. Walter Stiles has over many years earned a reputation for accuracy in recording facts, impartiality in presenting controversial matters, and a lucidity of expression rare among botanists.

The new edition is some eighty-five pages longer than the old, but it retains the latter's balance. All specialists, of course, will find the appropriate shortcomings: there will be some readers who are disappointed that such topics as respiration and photosynthesis are not given more up-to-date treatment, and other readers will cavil at the condensed accounts of anomalous osmosis and the physiology of reproduction. But discerning readers will remember that the book is the work of one man, and that it gains in homogeneity much more than it loses in detail—and of all subjects, plant physiology is the most in need of homogeneity. Indeed, if one has any criticism to offer to Prof. Stiles, it is in respect of the title of his book; for plant physiology has no principles. It cannot be presented even with the coherence of a fairy story, as the vascular cryptogams can, or with the reassuring monotony of a telephone directory, as the angiosperms sometimes are presented. Plant physiology is an unrelated succession of solutions to biological problems by chemical and physical techniques. It cannot, therefore, be summarized in a systematic way, and it cannot, therefore, ever make easy reading. An additional difficulty in presenting plant physiology is that the subject is in transition from a qualitative and descriptive phase to a quantitative and analytical one. Not only the older techniques, but also even the older philosophical approaches to plant physiology, are no longer adequate. Prof. Stiles does not evade these difficulties. He uses numerical data whenever possible. He eschews generalizations even when it would be tempting to make them; and he does not invest plant physiology with a misleading and attractive coherence.

A reading of Prof. Stiles's book does provoke the question as to how plant physiologists should be trained. To think usefully about respiration or nitrogen metabolism requires the discipline of an honours degree in chemistry. To think usefully about water relations and growth requires the disciplines of an honours degree in physics and mathematics. Further, if these topics are to be understood in their biological context, and not merely as branches of chemistry or physics, there can be no diminution in the amount of morphology or anatomy to be learnt by a plant physiologist: he must in addition have the discipline of an honours degree in botany. At present, most plant physiologists are botanists who have taught themselves chemistry, or chemists who have taught themselves botany. Perhaps the time has come to divide honours botany courses into non-experimental (with subsidiary zoology and geology) and experimental (with subsidiary chemistry and physics). It would mean that the student who graduated in experimental botany would no longer be familiar with the evidences of phylogenetic inertia in the pteridosperms; but if, instead, he knew enough chemistry to appreciate thoroughly Prof. Stiles's chapters on metabolism, the loss might be bearable. E. Ashby

HORTICULTURAL HISTORY OF THE UNITED STATES

A History of Horticulture in America to 1860

By U. P. Hedrick. Pp. xiii+551+32 plates. (New York and London: Oxford University Press, 1950.) 45*s*. net.

THE history of horticulture, as compared with the history of, say, botany, has been strangely neglected. It is true that the development of gardens and gardening has been well documented in many countries, but the making of a garden, though it may be the end, is not the whole of horticulture. Before a plant can take its place in a row of vegetables or in a well thought-out scheme of a landscape architect, it must have been collected from the wild, worked on, perhaps for years, by the plant breeder or selector, propagated and increased in a nursery, and catalogued, advertised and sold by the horticultural trade, wholesale and retail. This 'pre-garden' aspect of horticulture is set against a much wider background than is the art of gardening itself and offers a fascinating opportunity for the historian. This opportunity, as regards horticulture in the United States before 1860, has been taken with characteristic thoroughness and skill by Mr. U. P. Hedrick in his "latest volume"—a phrase, in the case of Mr. Hedrick, with more than its usual significance, for he has already, in a long succession of admirable books, made a most valuable contribution to horticultural literature. As horticulturist, and later director, of

the New York State Agricultural Experiment Station since 1905, he has had a unique opportunity for viewing American horticultural developments during the past fifty years and of obtaining the right perspective to deal with the history of earlier times.

His book is divided into three parts. The first covers native Indian and colonial horticulture; the second treats post-Revolution developments in the various States; while the third consists of chapters on 'botanic' explorers and gardens, plant breeding, horticultural literature and on horticultural societies. There are a bibliography and a model index of nearly three thousand entries, which make the book extremely easy to consult.

Mr. Hedrick, during the writing of his book, has had continuously in mind the social and economic background against which all horticultural development must necessarily take place, and this width of view not only makes clear the factors responsible for the changes he records but also clothes the bare bones of his story in a way that will appeal to a wide public. The uppermost thoughts in the minds of all British readers must surely be the desirability of tackling the history of their own horticulture on the same lines. It is to be hoped that this thought will take a more concrete form and that, inspired by Mr. Hedrick, a long-standing gap in British horticultural literature will be filled.

One slight word of warning may be given to non-American readers. The problem of Latin and vernacular names in books for the general public is always a thorny one. At one extreme, the Latin name may be given at every mention of a plant; at the other, such names may be shunned completely. On the whole, Mr. Hedrick has struck a happy mean; but in a number of cases American popular names, such as "pigweed", are used, either with no indication of their identity, or with such indication tucked away on another page.

The illustrations are excellent, and the book should be widely read, both for its own sake and as a model to be followed in other countries.

J. S. L. Gilmour

INVENTIONS, MONOPOLY AND THE PATENTS ACT 1949

The Patents Act, 1949

With a Commentary by the Chartered Institute of Patent Agents. Pp. vii+328. (London: Sweet and Maxwell, Ltd., 1950.) 37*s*. 6*d*. net.

Inventions, Patents and Monopoly

By Peter Meinhardt. Second edition. Pp. xvi+320. (London: Stevens and Sons, Ltd., 1950.) 30*s*. net.

THESE two books together will cover the needs of the large majority of persons who from widely differing points of view are interested in patent matters in Great Britain.

The first book embodies the texts of the Patents Act 1949 and Rules, and includes a detailed commentary on the Act section by section, prepared by a number of Fellows of the Chartered Institute of Patent Agents with the assistance of members of the Patent Bar. It has been prepared essentially for persons who specialize in patent work, and the purpose of the notes is primarily to point out those respects in which the new Act alters or adds to the existing law and to comment upon the changes. The book opens with a summary of the important and far-reaching innovations which have been introduced into the Act, principally as the result of the recommendations of the Swan Committee which was set up in 1944 under the chairmanship of Sir Kenneth Swan to examine in detail the British patent system. In the foreword welcoming the publication of this book, Sir Kenneth acknowledges the invaluable help which was given by the Chartered Institute of Patent Agents to his Committee in the shape of critical and constructive suggestions.

The book has a comprehensive index, and to assist practitioners in this field the text of the Patents Act 1949 is printed line by line identically with the copy of the King's Printer.

Mr. Peter Meinhardt's book, on the other hand, treats the subjects of patents and monopoly much more broadly. This is a second edition, completely revised so as to include the numerous changes in the law introduced particularly by the Patents Act 1949, and it will certainly be welcomed not only by legal practitioners but also by the large number of industrialists, commercialists and economists who knew the first edition. Mr. Meinhardt discusses the scope of the new provisions in the Act and the effect they are likely to have in relation to the interests of various classes of persons. He indicates the practical way in which the new Act may prove beneficial not only to those who are concerned with the patenting of inventions, but also to those members of the public who wish to use and exploit them.

In Part 1 Mr. Meinhardt discusses inventors and inventions—the motives prompting the inventor, the moral right of an inventor to reward and arguments for and against patent monopoly. In concluding this section, he states that, notwithstanding all its shortcomings, the patent system has been a practical success. It has acted as a stimulus to inventors and manufacturers of new articles.

Part 2 is devoted to the more legal aspect of applying for a patent and maintaining a patent, followed by fifty-seven pages on all forms of patent litigation. It gives a concise description of British patent law and practice in a readable form, and intricate legal points have been eliminated.

The abuse of patent monopoly is dealt with in Part 3. Ever since its inauguration, British patent law has recognized the necessity for safeguards against the abuse of monopoly. Under the Patents Act 1949 the principal sanction in a case of such abuse is the grant of a compulsory licence to a specified person. Mr. Meinhardt deals with such questions as the wrongful refusal by the patentee to grant licences on reasonable terms; excessive prices charged for patented articles; wrongful attempts to extend the ambit of the patent monopoly; unwarrantable threats under patents. In the last chapter he discusses the scope of the Monopolies and Restrictive Practices Commission set up in 1948, a subject which is becoming of increasing public interest. He points out that the British approach to the problem of monopoly under the British Monopolies Act differs entirely from the American approach based upon the Sherman Anti-Trust Act of 1890.

Mr. Meinhardt has had the advantage of being able to combine a wide practical experience of business methods in many countries together with detailed experience of the corresponding patent laws. This unique experience is reflected in this book in a manner which will make it invaluable to a wide range of the public.

R. G. Lloyd

Practical Applications of Spectrum Analysis

By Dr. Herbert Dingle. Pp. ix+245+19 plates. (London: Chapman and Hall, Ltd., 1950.) 40*s*. net.

FOR more than half a century there has poured from what has become known as "Fowler's Laboratory" at the Imperial College of Science and Technology, London, a steady stream of research papers on spectroscopy. Little on technique has, however, been published; and to those who knew something of the great variety of problems successfully tackled in the laboratory, it had seemed possible that much accumulated practical experience handed down from Lockyer and Fowler, and added to year by year, might be lost except to their direct successors.

The appearance of this welcome book has now averted this danger. Prof. Herbert Dingle, himself for long Fowler's right-hand man, has distilled into its pages the essence of nearly thirty years of experience in the practical application of the spectroscope to chemical analysis. Though it is in no sense a work on theoretical spectroscopy, enough background in optics and atomic structure is given to enable the laboratory worker to make the most intelligent use of his instruments. Armed with this book and a table of wave-length identifications, the practical spectroscopist should be able to attack analytical work in any field of study in which the method is at all applicable.

As is perhaps inevitable in the present state of knowledge, little space is given to quantitative analysis, where the author contents himself with laying down general principles without descending to empirical methods of limited application. A long chapter is devoted to a detailed discussion of the line spectra of individual elements, in particular their behaviour as traces in mixtures; this and the excellent collection of spectrograms reproduced in half-tone make the book worth its admittedly high price.

Induction Heating

By N. R. Stansel. Pp. viii+212. (London: McGraw-Hill Publishing Co., Ltd., 1949.) 34*s*.

THE heating of metals by the induction of eddy currents in the material to be heated is now a well-established industrial operation; the induction furnace has its own field in the metallurgical industry, and induction equipment for surface-hardening and other operations requiring a brief but accurately controlled heat cycle is widely used in mechanical engineering. There are already a number of books on the subject, some expounding the principles for the benefit of electrical engineers who are concerned with the making of the equipment, and others chiefly concerned with describing the uses of a comparatively new tool.

This present book is certainly not in the latter class, but it is none the less difficult to regard it as an exposition of principles; it is much more of the nature of a handbook of formulæ and data relating to the electrical and thermal quantities involved. The chapters are broken into very short and somewhat disjointed paragraphs, and any formula required is stated quite baldly with almost no explanation or discussion. The author makes a point of representing nearly every equation by a curve, which admittedly enables the reader to visualize the rise and fall of the quantities, but it is difficult to believe that without a more adequate discussion he would be able to judge whether the curve had any application to his own work. The data collected from many sources may well be useful to the engineer already familiar with the subject. It is a nice point whether he will prefer to find his magnetic induction given in "kilolines per square inch" as it is in some places, or in "gausses" which appear in others. L. H.

High Vacua

Principles, Production and Measurement. By Dr. Swami Jnanananda. Pp. xiii+310. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 41*s*. net.

DR. SWAMI JNANANANDA'S book is written from the point of view of a physicist rather than a technologist, and therefore starts with a full chapter on the kinetic theory of gases. This explanation of vapour pressure, viscosity and molecular streaming forms an excellent theoretical background to vacuum practice. The succeeding chapter on pumps gives a fairly complete description of most types of mechanical, molecular and diffusion pumps using both mercury and high-boiling-point organic liquids, although the widely used Kinney mechanical pumps and the silicone fluid for diffusion pumps have unfortunately been omitted. The section on gauges covers manometers, and McLeod, Pirani, viscosity, ionization and radiometer gauges, the last type in great detail considering its limited popularity. One notable omission is the cold-cathode discharge tube, particularly Penning's very useful modification. The least satisfactory section of the book is that on vacuum systems, as it tends to concentrate on the older 'sealing wax' techniques, and omits rubber gaskets, Wilson spindle seals and modern glass-to-metal seals.

Apart from the criticism of omission, the book is readable, clearly illustrated, well referenced and indexed, and is a useful addition to the vacuum physicist's bookshelf. R. O. Jenkins

Acetylene and Carbon Monoxide Chemistry

By John W. Copenhaver and Maurice H. Bigelow. Pp. xvi+357. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1949.) 80*s*. net.

THIS book is based on a report, presumably that published by Charles A. Meyer and Co. as P.B. Report 18852-*S*, which was written by J. W. Reppe while he was detained, under the supervision of one of the authors, by the United States Army in 1945. The plan of the book closely follows that of the report, all of which is substantially included but amplified and with the addition of information drawn from the reports of post-war investigators into the German chemical industry and other literature.

After a chapter on the synthesis of acetylene and its reactions at atmospheric pressure, the authors devote the remainder of the book to reactions at high pressure, with chapters on vinylation, ethinylation, the reactions of ethinylation products and one on polymerization to *cyclo*octatetraene and its reactions, the first two chapters having appendixes giving lists of the products obtainable and their melting or boiling points, and the last an appendix giving details of the derivatives of *cyclo*octatetraene. The book concludes with chapters on the reaction of acetylene with carbon monoxide, the preparation and reactions of acetylene homologues and finally the practical aspect, namely, details of experiments on the explosion of acetylene and the technique and equipment for its safe handling under pressure—a subject not discussed in Reppe's report.

SCIENTIFIC INSTRUMENTS FOR RESEARCH AND INDUSTRY

PHYSICAL SOCIETY'S EXHIBITION 1951

THE thirty-fifth annual exhibition of scientific instruments and apparatus, organized by the Physical Society, was held at the Imperial College, London, during Friday, April 6, to Wednesday, April 11 (Sunday excepted). As in the previous year, it was again found advisable to spread the period of the exhibition over five days and, by a special system of issue of tickets, to limit the numbers attending any particular session. In addition to this restriction in the issue of tickets, the exhibition was expanded into the Huxley Building in Exhibition Road—thus providing more space both for the exhibitors and the visitors. The arrangements proved in the main very satisfactory, but of course there was a certain disadvantage in dividing the exhibition into two rather widely separated parts; fortunately, the weather at the time had improved, and the inconvenience of crossing from the Imperial College to the Huxley Building was not so serious as it might have been. During the five days in which the exhibition was open, a total of approximately 17,000 visited the exhibition—of these at least 80 per cent crossed over to the Huxley Building. This number of visitors represents an increase of 3,500 on the previous year.

The president of the Physical Society, Prof. L. F. Bates, in his two formal openings of the exhibition—the first at 10 a.m., April 6, for Fellows of the Society and the Press, and the second at 2 p.m. on the same day for the general public—made a brief reference to the main objects of the Physical Society and to the manner in which the exhibition furthered these objects in bringing together annually the manufacturers of scientific instruments and the research workers and teachers who make use of them. He also made special reference to the extension of the area of the exhibition to the Huxley Building, and to the exhibits from three research departments of the French Government. He paid a tribute to the excellence of the scientific instruments on view and to the great achievements of the British scientific instrument industry.

During the exhibition, four discourses were given by eminent authorities in different branches of physics. The first of these was by Dr. G. E. R. Deacon, director of the National Institute of Oceanography (at present housed at the Admiralty Research Laboratory, Teddington). His subject was "Electric Currents in the Sea". He first referred to the earlier work on this subject by Admiralty and other scientific workers, notably the researches of Young, Jevons and Gerrard, which had demonstrated the existence of diurnal variations of electric current due to tidal flow of a conducting medium (the sea) cutting the lines of the earth's magnetic field. It was realized that it should be possible to obtain quantitative information about tidal streams and other water movements by recording horizontal potential gradients induced by these water movements. If a pair of stationary electrodes is spaced on a line transverse to the stream, the potential difference between them will depend on (*a*) the earth's vertical field, the stream velocity and the distance between the electrodes, and (*b*) the degree to which the sea bed short-circuits the induced E.M.F. In the absence of precise information about the conductivity of the sea-bed, it is necessary to calibrate the measurements by measuring the stream velocity. If the electrodes are connected by a wire to a voltmeter and the whole system is allowed to drift with the stream, an E.M.F. will be induced in the wire equal to that which is induced in the water, and the voltmeter will register only a voltage which corresponds to the flow of electricity between the electrodes. It depends on the electrical conductivity of the water path between the electrodes and the conductivity of the return path through the sea-bed or through stationary ocean water over which the stream flows. Dr. Deacon referred to the work of Barber and Longuet-Higgins on this subject, directing attention also to the magnetic effects produced by earth currents of all kinds.

The second discourse, on Monday, April 9, was given by Dr. D. McKie (University College, London) on "The Age of Newton". His lecture covered the following subjects: the foundation of the Royal Society of London and the Paris Academy of Sciences; the publication of the *Philosophical Transactions* and the *Journal des Savants*; Newton's early life and studies; Cambridge and the Royal Society; the great discoveries on gravitation and light, and the invention of the calculus; Newton and his contemporaries; his character; Halley and the "Principia"; Newton and Hooke; Newton as president of the Royal Society; his last years and his influence on the science of his times and on his successors.

On April 10, Dr. F. P. Bowden's discourse dealt with "The Friction of Metals and Non-metals and the Influence of Surface Films". In introducing his subject he quoted from the writings of Leonardo da Vinci in the fifteenth century. Leonardo expounded the laws of friction and referred to the interposition of thin films or layers between surfaces to "lighten the load". Dr. Bowden then described recent experimental studies in Cambridge of the friction of clean metals and the influence of adsorbed films on the friction, adhesion and surface damage. Clean deoxidized surfaces of metals in a vacuum weld together when brought into contact. The effect of hydrogen, oxygen, water, chlorine and sulphur has been investigated and it is found that both chemisorption and a reversible van der Waals adsorption are important. Analogous experiments have been made with non-metals, particularly with outgassed surfaces of diamond, carbon and graphite. Here also the adsorbed films have a profound influence. Further study has been made of the high temperatures developed at the rubbing points of contact between non-conductors, and measurements have been made of the rise and fall of the 'hot spot' temperature with non-metals. The effect of temperature on the orientation and disorientation of boundary films of lubricants were described, and the relation between the intermetallic adhesion and the structure of the boundary film was discussed. Dr. Bowden showed

some simple, but very striking, experiments on the reduction of friction between metallic surfaces by the use of the fluorine compounds 'Teflon' and 'Fluon'. A toy motor with metal wheels ran up a steel slope without hesitation, but a similar motor with its wheels coated with 'Teflon' or 'Fluon' refused to climb beyond the foot of the slope. Similarly, a coating of indium on steel resulted in a drop in the friction coefficient. In this case also the friction decreased with increase of temperature up to a critical limit. Molybdenum sulphide evaporated on to sintered copper, or better still formed on a surface of sintered molybdenum, resulted in a spectacular fall in the friction coefficient (to about 0·02). Experiments to demonstrate this were made with a pair of similar heavy pendulums in (*a*) molybdenum sulphide bearings (heated by a gas flame) and (*b*) steel bearings lubricated by 3 in 1 oil. Both pendulums were set to swing at the same initial amplitude, but the molybdenum sulphide pendulum continued to swing with a considerable amplitude long after the steel pendulum had stopped. Similar striking demonstrations were made by sliding small weights coated with various films down an inclined plane.

Dr. L. A. Sayce, superintendent of the Light Division, National Physical Laboratory, gave the fourth discourse, on April 11, his subject being the activities of the Laboratory's Light Division. His object was to show how it maintains and administers the national standards of illumination and radiation and to discuss some of its past and present researches. His lecture dealt with the two themes : (*a*) light as a form of energy measured in physical units of energy ; and (*b*) light as a stimulus of the sense of sight, the motive power of the eye, measured in units of sensation. The Radiation Section of the Light Division is concerned with radiation extending from a wave-length 0·2 μ, where quartz begins to be transparent, and ends at 15 μ, where rock salt begins to be opaque. Sources of radiation in this range vary from the hydrogen lamp in the ultra-violet to the bare radiator in the infra-red. Standards of energy measurement are based on the Callendar type standard (using the Peltier effect in a thermocouple) and the Guild type standard (which equates the Joule heating effect with the radiation heating). Sub-standard radiation receivers are thermopiles of the Moll type calibrated from the Guild standard. The Radiation Section is also concerned with measuring the spectral sensitivity of photocells. At this point in his discourse Dr. Sayce referred to the eye as a photocell. The eye is comparatively useless as a *measuring* instrument ; but it is excellent as a means of *comparing* stimuli both as regards brightness and colour. It is, of course, decidedly selective in its spectral response and varies from person to person. But the National Physical Laboratory has deduced, from tests of a large number of eyes, what is called a 'standard observer'. This hypothetical person has an eye which has a maximum sensitivity at $\lambda = 0{\cdot}5550\,\mu$. Another responsibility of the Light Division is the fundamental unit of photometry, the candle power or candela. After describing the historical development of candle power standards, Dr. Sayce referred to the modern unit, which is defined in terms of a black body at the temperature of a freezing platinum surface.

Dr. Sayce next dealt with the measurement of colour, a subject with which his colleague, Mr. J. Guild, has long been identified, referring to the various 'colour triangles', Guild's colorimeter, and Donaldson's '3-primary' and '6-primary' colorimeters and their method of use. In conclusion, he referred to an interesting line of research which is at present under way at the National Physical Laboratory. This is based on a new method of ruling diffraction gratings suggested by Sir Thomas Merton. The general idea is to rule the gratings as a helix upon a cylinder and then open it out on a flat surface by means of a replica process. The experiments were started by copying flat gratings by the use of suitable plastics, and stripping and re-mounting methods. Having developed the replica copying process, attempts were next made to 'rule' accurate helical gratings of 15,000 lines per inch on cylinders. The periodic errors which inevitably arise in screw-cut threads were entirely removed by a simple method devised by Sir Thomas Merton, known now as the 'Merton nut' method. This has resulted in the production of plane gratings of a very useful quality, and it is hoped that good gratings will no longer be the rare and expensive things which they have been in the past.

This year, one hundred and thirty-seven firms and research organizations displayed their scientific instruments and apparatus. To avoid certain incongruities in the method of display, so noticeable in earlier exhibitions, the name-plates and stand numbers on this occasion were standardized. The improvement in the general appearance of the stands was quite marked. A list of exhibitors and a description of the exhibits are given in the Handbook of Scientific Instruments and Apparatus 1951 (35th Exhibition), published by the Physical Society (price 5*s*.), pp. xi+244+A72. This is a very useful reference book, well produced on art paper and containing a plentiful supply of illustrations (half-tone and diagrammatic). As usual, all branches of physics are well represented in the exhibits, and most of the 17,000 visitors, whatever their special interest, must have found something novel to attract attention.

As the president mentioned in his opening address, a noteworthy feature of the exhibition this year was the exhibits of three research organizations of the French Government. The first of these, Centre National de la Recherche Scientifique, was showing various optical devices, notably phase-contrast oculars for the microscopic study of transparent and reflecting objects, a device for increasing the numerical aperture of microscope objectives and an attachment for converting an ordinary microscope into a variable-phase contrast microscope. In addition to these optical devices, a high-tension electrostatic machine was shown which develops a power of 50 watts at 500 kV. The second French government organization, Commissariat à l'Énergie Atomique, exhibited a number of devices used in atomic energy investigations, namely, survey equipment, (*a*) 'gamma-phone', for audible detection of gamma-radiation, and (*b*) portable beta-gamma survey ratemeter ; scaler of 1,000, pocket dosimeter, coincidence amplifier and four-channel pulse-amplitude analyser ; also a three-stage oil diffusion pump having a speed of 5,000 litre/sec.—first made to evacuate a cyclotron. The third organization, Office National d'Études et de Recherches Aeronautiques, showed an infra-red gas analyser which could estimate an absorbing gas mixed with a non-absorbing gas down to 0·0001 per

cent; a rogascope—an electromagnetic apparatus for the detection of cracks or variations of diameter of wire threads, whether insulated or not, of non-magnetic metals, in particular molybdenum and tungsten (the use of this device results in considerable economies to manufacturers of valves, etc., where it is important to have reliable filaments). This organization also showed an oersted meter (range from tenths of a millioersted up to 1 oersted), a remanometer, magnesium electrode batteries, and miniature permanent magnet motors, 'Microtax' and 'Birotax' types. These small motors have extremely low inertia, and this allows almost instantaneous starting and stopping. The weight of the rotor in the 'Microtax' is only 5 gm. and in the 'Birotax' 16 gm., the respective powers being 0·5 watt and 5 watt.

It is difficult to make a representative selection of exhibits to which to refer in a brief article of this nature, and the following are chosen almost at random. An interesting development in laboratory balances was shown. This has a capacity of 10 kgm. and is designed for automatic loading of weights and charge from a remote-control unit. Weight loading and beam release are operated by geared slave motors. A small electric truck, which is also controlled from the operating unit, can be driven on to the pan. An automatic micro-pipette was shown which delivers a measured volume of liquid from a surplus in the pipette, and dispenses only the amount to which the device has been set; the error due to drainage is eliminated as the tube is not completely emptied. The Cavendish Laboratory and Birkbeck College research staffs showed their pendulum inclinometer for the measurement of glacier flow. The velocity distribution in a vertical profile through the glacier is obtained from measurements of the lateral displacement of the ice at various depths. Developments in planimeters illustrating the progress from the early form of this instrument were shown—the continuous chart planimeter, rule-form planimeters for non-uniform charts, integrators and harmonic analysers. An interesting variety of thickness meters was on view. In one of these a 'pocket-sized' magnetic gauge was used for the measurement of non-ferrous layers or films on ferrous bases (in ranges of 0 to 5, 0 to 10, or 0 to 30 thousandths of an inch). Another type used the radiation from radioactive thallium-204 and was capable of measuring 0·0005–0·10 in. of paper or equivalent weights of other materials. A radioactive β-ray source was used in a thickness or weight gauge—for materials such as paper, board, plastic sheet, metal foil, etc.—during the manufacturing process or in the course of subsequent inspection. The range of this gauge is 0–150 mgm./cm.^{2}—equivalent to 0–0·06 in. of paper or 0–0·025 in. of aluminium foil. Another entirely different type of thickness gauge enables the thickness of a slab of non-metallic material to be measured in terms of its dielectric properties. Thicknesses up to $\frac{1}{2}$ in. can be measured with an accuracy of 0·2 per cent. An interesting exhibit demonstrated a twist test for wire, giving data which can be correlated to its coiling properties. The wire under test is twisted on its own axis while under tension, and the change in length and number of turns are measured. A precision mining aneroid was shown which is fitted with a micrometer dial. The instrument covers a range from 24 in. to 38 in. pressure of mercury, the dial being subdivided into 0·1-in. divisions, and micrometer dial readings are obtainable to 0·001 in. A hand-operated adjustment is provided to set the micrometer dial to zero.

The Admiralty Research Laboratory (Teddington) showed an interesting piezo-electric pressure recorder, designed to give a continuous record on paper tape of sea waves. It is provided with a time mark coding device, and enough tape is supplied for a continuous record over a period of seven days, without attention. A correlation meter was also shown which automatically prepares cross- or auto-correlograms from black-and-white records on the same time-scale. Corresponding amplitudes are measured photoelectrically and their sum squared electronically. A twelve-channel galvanometer recorder developed for field-use where compactness, simplicity and ruggedness are important was also demonstrated; it operated from bonded resistance strain-gauges without amplification of the signals. The Admiralty Experiment Works (Haslar) staged an exhibit illustrating research on the steering qualities of ships. Prescribed manœuvres are executed by a ship model and the turning path is plotted from photographic records. Force and torque on the rudder stock are recorded electronically, and the distribution of pressure on the rudder is recorded by manometers. The Meteorological Office exhibited a method of measuring the vertical depth (or height) of a fog layer. The method makes use of photocells on tethered hydrogen balloons to detect light scattering of fog particles. There appears to be an increasing interest in rheometers and viscometers, and a number of varieties of these were shown. Zirconium metal is now available in moderate quantities; sheets down to 0·005 in. in thickness, 6–7 in. in width, and 2–3 ft. in length are now available, swaged rod down to 2 mm. diameter can be supplied, and methods for production of zirconium wire are being developed. This metal has excellent resistance to corrosion which, in addition to its peculiar property of attaching itself to surrounding flesh, makes it of considerable value in surgery. Tantalum and molybdenum sheet are also available now. On the electrical side, vibrating reed electrometers are gaining popularity. One of these, designed by the Atomic Energy Research Establishment, Harwell, measures currents as low as 10^{-16} amp. The commercial form is provided with full-scale readings of 1 mV., 10 mV. and 100 mV.; the input resistance of the vibrating reed unit is greater than 10^{16} ohm. The vibrating reed electrometer provides an alternative to most forms of valve electrometer, having a greatly improved zero stability, and is designed primarily for measurement of ionization currents. It is used at Harwell in the determination of α-particle energies.

A large variety of gas analysis equipment was shown. These instruments indicate, or record electrically, water vapour in coal gas, air–gas ratio, organic vapours, dissolved hydrogen in boiler condensates, oxygen, etc. A fascinating demonstration showed the piercing of a diamond by an electric spark. The technique is particularly suitable for producing diamond dies of small bore, and holes of 0·0002 in. diameter have been produced in this way. The growth of sizeable quartz crystals by a hydrothermal process was shown, the crystals being suitable for telecommunication purposes. Germanium diodes and triodes, and barium titanate resonator elements were shown. High-vacuum equipment included not only the latest forms of pumps but also ionization gauges of various kinds, a palladium ionization gauge

leak detector, and evaporation plants for metallizing surfaces.

The Science Museum (South Kensington) exhibited apparatus devised or used by Sir Charles Wheatstone (1802–75), namely, the original rheostat and Wheatstone bridge described in 1843, apparatus which he used in 1834 to measure the speed of electricity in a wire, his telegraphic thermometer and his cryptograph.

The Admiralty Signal and Radar Establishment (Haslemere) showed a nice collection of metallized-glass microwave components and resistors. The metal used is nichrome, its resistance being measured during evaporation in a vacuum. It is used as waveguide attenuator vanes and coaxial terminations in the 3-cm. and 10-cm. wave-bands. An unusual type of electrolytic condenser having a capacity of 55 μf. at a working voltage of 80 V. D.C. using tantalum as the electrode metal and sulphuric acid electrolyte was shown. This miniature condenser, not much larger than a shilling, has satisfactory characteristics of capacity and power factor at 60 c./s. through the temperature range −70° C. to +200° C. The research department of the same firm also showed a soft magnetic core material, 'Caslam', with a finely laminated structure, for use at frequencies up to 10 kc./sec. It has a ring permeability of the order of 1,000 and is composed of flake iron particles pressed compactly in such a way as to produce innumerable thin magnetic layers aligned in the plane of the flux. In another exhibit a series of high-voltage generators using the radio-frequency method of voltage transformation was shown. Use was made of voltage multiplier circuits, and any voltage up to 100 kV. at 0·5 m.amp. could be provided in a very small bulk. Accurate automatic recording of the polar diagrams of centimetric antennæ mounted on the roof of a rotatable trailer can be made while the receivers are illuminated by a fixed transmitter. The amplitude of the receiver signal is plotted continuously against the angular traverse of the trailer and test antenna. A scintillation counter using an E.M.I. photomultiplier tube is used with the crystal exposed for radioiodine work on the thyroid, etc., and various types of radiation monitors for β-, γ- and X-rays were on view. A series of diagrams was shown explaining the principle of the travelling-wave linear accelerator developed at the Telecommunications Research Establishment, Malvern, and the Atomic Energy Research Establishment, Harwell. Details were given of the 3·5-MeV. machine installed at Harwell. The machine has a corrugated wave-guide 2 metres long, the radio-frequency pulses being derived from a 10-cm. magnetron and modulator. The manner in which the principle is now being applied to the production of high-voltage X-rays for the treatment of cancer was also shown. Another exhibit showed the latest form of mass spectrometer, of the 90° sector type designed primarily for the determination of abundance ratios of stable isotopes in the range 1–70. On the same stand was shown an electron diffraction camera, with automatic focusing, to give maximum beam-intensity compatible with small spot size; a stable high-frequency D.C. set giving 25, 50, 75 and 100 kV. also forms part of the instrument.

Reduction of surface reflexion by 'blooming' has now been achieved by the Telecommunications Research Establishment in the 8–9 mm. wave-length band. The reflexion coefficient of a dielectric is reduced from 20 to 2 per cent by correct grooving of its surface. In the realm of optics, the Colour Group of the Physical Society made a striking display illustrative of the history of colour vision from the time of Boyle and Newton to the present day. A new series of photocells, made by Schwarz, was exhibited. They are of cadmium sulphide (and/or selenide) having sensitive areas approximating in size to that of a linear thermopile for spectroscopic use. Synthetic mica may now be used for windows of ultra-violet lamps, as it has appreciably higher transmission in that region of wave-lengths than any of the natural micas. It has the additional advantage that it can readily be fused to glass to form windows. The Armament Research Establishment exhibited a repetitive Kerr cell camera which takes a sequence of 80 photographs at a rate of 400,000/sec.; each picture is exposed for 0·1 μsec. The Light Division of the National Physical Laboratory demonstrated new developments in the cathodic sputtering of non-metallic films—films of oxides or sulphides of metals such as cadmium or zinc. Argon is added to the vacuum gas (oxygen or hydrogen sulphide) to increase the rate of sputtering. These films are interesting for their optical and electrical properties.

In acoustics, new developments in acoustic strain-gauges were illustrated, and an automatic high-speed level-recorder (of the Neumann type) was shown. The latter records response characteristics on a logarithmic scale. An acoustic controller of the feed-rate in a steel ball mill was exhibited. The noise of the mill is a criterion of the state of grinding of the balls and controls the feed-rate automatically. An ultrasonic scanner for flaw detection had novel features. The ultrasonic beam scans the material to be tested while an electron beam of an oscilloscope is deflected in a television type raster, in such a way that an image of the flaw is generated. In the thermal field, an interesting exhibit illustrated the use of glass fabric – metal wire bands and mantles for heating pipes, flasks, etc., in the laboratory. Another exhibit illustrated the Golay pneumatic infra-red detector; in this a membrane absorbs the radiation passing through a potassium bromide window and in turn heats the gas in contact with it; the pressure is thereby increased and is indicated by a simple optical system. A simple device for measuring heat flow consists of a 12-mm. disk of tellurium alloy faced on either side with copper elements. Heat flow through the sandwich generates an E.M.F. proportional to the heat-current density. The device has many useful applications.

As in previous exhibitions, an important feature was the craftsmanship competition. A splendid display of glass-blowing, instrument-making, designing and draughtsmanship was on view. The judges must find it a very difficult task to allot the prizes when so much excellent work is shown. In the case of glass-blowing, the first and second prizes were awarded to two excellent examples of the art of glass-blowing, of no utilitarian value. Other very praiseworthy efforts, resulting in less spectacular but more useful articles, received only 'special mention' prizes. This gives the impression that the competitors are not altogether clear as to what is required of them.

The exhibition, like its predecessors, was a great success and much credit is due to the Physical Society for organizing it, and to the scientific instrument industry for providing such a wonderful display of high-class workmanship.

A. B. Wood

BLOOD GROUPS AND ANTHROPOLOGY

RESEARCH into the distribution of the blood groups has progressed rapidly in recent years, and there has been a growing feeling among anthropologists, serologists and geneticists that this field of joint effort should receive more definite recognition than it has had in the past. An important stage in such recognition was reached when about one hundred and fifty workers in these three branches of science attended a symposium on "Blood Groups and Anthropology", organized by the Royal Anthropological Institute, and held at the Galton Laboratory, University College, London, on March 17.

The chair at the morning session was taken first by Prof. H. J. Fleure, and then by Dr. J. C. Trevor.

Prof. R. A. Fisher, introducing the subject, expressed his pleasure at addressing a meeting in his old Department, and at seeing present several of those who collaborated in his early work on human blood-group genetics. He said that when he began his work, there was still some general reluctance to accept the surprising discovery that the differences between brothers and sisters might be of the same kind as those between different races of a species or even between different species. In his approach to human genetics he was influenced by the pioneer work of Todd, who first showed the extreme complexity of the blood-group systems in cattle. Thanks to the generosity of the Rockefeller Foundation it became possible to set up a serological unit in the Department, in the charge of the late Dr. G. L. Taylor, a unit which later acquired an independent existence as the Galton Laboratory Serum Unit when it moved to Cambridge and carried on special war work under Dr. Taylor, and later under Dr. R. R. Race. Since the genetics of the *ABO* blood-group system were first established, new human-blood groups and other genetical factors of classificatory value have continued to be discovered at an ever-increasing rate, each in turn gradually becoming available as an anthropological tool. Prof. Fisher said he anticipated that in the next twenty-five years many more such racial discrimina would be placed in the hands of anthropologists.

Dr. C. D. Darlington, speaking on "Blood Groups and Mating Groups", pointed out that man is unique among living species in that almost complete distribution maps can be prepared for some of his genes, namely, those determining the blood groups. In Europe there is a remarkable accord between the frequency map of the blood group *O* gene and a map showing the ability to pronounce the *th* sound in modern and historical times. This has demonstrated the genetic control of linguistic development by racial groups.

The usual isogene maps covering large areas illustrate clines resulting from population movements and the consequent spreading of genes. We should, however, expect that, under settled conditions, inbreeding and genetic drift would superimpose on the smooth clines a minor pattern of local fluctuations. The uniquely extensive and detailed records of the blood transfusion services of Great Britain might have been expected to reveal such patterns if subjected to minute topographical analysis, and recent work has shown that they, in fact, do so. This dependence of the distribution of physical characters upon breeding habits affords a meeting place for physical and social anthropology.

The methods and results of a detailed analysis of the records of the National Transfusion Service for the three northern counties of England and the North Riding of Yorkshire were then described by Dr. J. A. Fraser Roberts. He first referred to previous work in Great Britain. He himself in the west of England found no significant fluctuations in blood-group frequencies, but he did not subdivide this area anything like as finely as he did the north. He then turned to his recent work and described how he had analysed the record cards of some 51,000 donors in the north of England by means of a Hollerith punch-card system. The records of individuals were combined on a topographical basis into groups of not less than twenty individuals. These groups were then further combined on a basis of blood-group frequencies into areas separated so far as possible by natural or important artificial features, such that the whole of the significant variation lay between areas and none of it within areas. This sufficed to define nineteen areas with *A* gene frequencies varying from 19·0 to 32·2 per cent. For the *B* gene, with its general low frequency, the analysis had to be less detailed, but fifteen areas were defined, with *B* gene frequencies from 4·3 to 7·9 per cent. The resulting patterns for the whole area are relatively simple.

In contrast to the relatively small local fluctuations, probably of historically recent origin, in the north of England, are the wide and very ancient variations described for Wales and the Marches by Dr. I. M. Watkin. Dr. Watkin explained how, in the course of his work as a transfusion officer, he had been able to question blood donors with Welsh names, ascertaining their place of birth and the maiden names of married women. He analysed topographically the blood-group data of all those who were born with Welsh names and so obtained a picture of the distribution of the blood groups in the Welsh people, uninfluenced by the effects of recent immigration. High *O* frequencies were found throughout most of North Wales, and very high frequencies along the north coast and the northern part of the west coast. In South Wales, high *O* frequencies are mainly confined to a few mountain areas. Thus it appears that high group-*O* frequencies are characteristic of an old population in the less accessible mountain areas and high *A* frequencies represent relatively recent immigration.

Similar high *O* frequencies are found not only in Scotland, Ireland and Iceland, but also in various areas in southern Europe and among certain Berber tribes in north Africa. In this connexion, Dr. Watkin pointed out that there is an important pre-Aryan element in Welsh syntax, and that the structure of the Welsh language is held by some philologists to show a remarkable similarity to that of the languages of the white peoples of north Africa.

Some years ago, Prof. Fleure demonstrated the existence, in certain remote moorland areas, of skeletal types resembling those of late palæolithic man. In precisely those areas there are found very high frequencies of blood-group *B*, higher than anywhere else nearer than eastern Poland. Thus the *B* gene, once supposed to have first entered Europe during the Christian era, is, in fact, abundantly present in populations which are among the oldest found anywhere on the Continent and its islands.

High *A* frequencies, resembling those of Scandinavia, have been found in the Gower Peninsula of Pembrokeshire and near the mouth of the River Dee, where there is other evidence of Viking settlement; and there is genetical evidence of a similar component in Anglesey and near the mouths of the Rivers Clwyd and Conway. Near the English border interesting patterns of interpenetration can be traced between the Welsh with a high *O* frequency and the Anglo-Saxons with relatively high *A*.

Dr. A. E. Mourant then described "Recent Advances in Serological Anthropology", expressing his intention of summarizing the distribution of the blood groups in those parts of Europe and the world not covered by previous speakers. He exhibited new *ABO*- and *Rh*-gene frequency maps of Europe, of which the former can readily be interpreted in terms of a succession of waves of population moving from east to west, mentioned by Drs. Darlington and Watkin.

The distribution of the *Rh* chromosomes, or gene triplets, he said, is remarkably uniform over the whole of northern and central Europe, with about 40 per cent of *cde*, the main *Rh*-negative combination. The Basques, with more than 50 per cent of *cde*, possibly represent the original source of most of the chromosomes of this type. In the Mediterranean area, *cde* is much less common, while *CDe* rises to about 60 per cent. At the same time, the *Rh*-blood groups enable one to trace many details of mixing of a basic Mediterranean population with northern, Basque and Negro components. Recent unpublished discoveries of Dr. D. Messerlin suggest that the Berbers of the Great Atlas Mountains are closely related to the Basques.

In tropical Africa, we again find a very uniform *Rh* distribution, with about 60 per cent of *cDe* and 20 per cent of *cde*. The distribution of the *ABO*- and *Rh*-groups and of the congenital blood anomaly characterized by sickle-shaped red cells all point to the Pygmies of central Africa as representing one of the two or three major components which enter into the composition of the peoples of Africa as a whole.

Throughout eastern Asia, the Pacific Islands and among the aborigines of Australia and America, the *CDe* chromosome is dominant, with rather a high frequency of *cDE* in Maoris and American Indians.

The *MN*-groups have, on the whole, yielded less information of anthropological value than the *ABO*- and *Rh*-groups. The most striking feature which they show is a sudden drop from a high to a low *M* frequency in passing from Java to the rest of Indonesia, the division approximately following Wallace's line.

The blood-group antigen Duffy, recently discovered by Miss M. Cutbush, Dr. P. L. Mollison and Dr. D. M. Parkin, shows the widest possible variations in frequency and will be of great anthropological value when sufficient serum becomes available. The even more recent discovery of the Kidd antigen, by Dr. F. Allen, of Boston, Mass., also promises to be of use in anthropology, as Miss E. W. Ikin has just found it to be much commoner in Negroes than in Europeans.

The American Indians and Eskimos show a general resemblance in their *Rh*-groups to the peoples of eastern Asia and the Pacific region, but the Americans have much higher *M* frequencies and, apart from the Alaskan Eskimos, were probably originally completely lacking in *B*, which is common in eastern Asia and present in most Pacific island peoples. Dr. Mourant said that it is hoped that detailed blood-group research in eastern Siberia will one day be possible, for it may throw important light on the origin of the Pre-Columbian Americans.

A series of diagrams illustrating blood-group genetics was exhibited by Drs. R. R. Race and Ruth Sanger.

The afternoon meeting, with Miss M. L. Tildesley in the chair, took the form of a discussion on the organization of investigations in blood-group anthropology. Prof. H. J. Fleure suggested the formation of a co-ordinating centre for such work, under the ægis of the Royal Anthropological Institute. Prof. R. A. Fisher pointed out the value of such a centre for the reception of unpublished results and of the details of observations where these were too extensive for full publication. He stressed the importance of starting such a centre as soon as possible. Dr. A. Allison suggested that the centre should actively initiate or suggest new researches, and considered that field-work should to a large extent be decentralized.

Several speakers pointed out the difficulty of the techniques and the rarity of many of the necessary testing sera, both of which factors would for some years to come make it necessary for much of the work to continue to be done in a few central laboratories, the specimens being sent to them by air in most cases. Dr. G. Discombe considered that the stages of any decentralization should be under close control by workers who themselves understood the tests and their difficulties.

The use of existing and future transfusion service records was next considered, and Dr. W. d'A. Maycock described the nature of the records of the National Blood Transfusion Service of England and Wales, and their anthropological value, pointing out the need for guarding against certain statistical errors which might arise if great care were not exercised in using the records for anthropological purposes.

The final topic was the systematization and use of existing published records. Dr. A. E. Mourant pointed to the rapid rate at which material is being published, scattered in very numerous journals, many of which are not readily accessible. He considered that this material, especially that published since Dr. W. C. Boyd's compilation of 1939, should be collected, tabulated and published with uniform statistical treatment. This would occupy the whole time of at least one worker.

Prof. H. J. Fleure then proposed that the Council of the Royal Anthropological Institute should be asked to set up a committee to consider and make recommendations on the use of blood groups in anthropology. This proposition was accepted unanimously.

OBITUARIES

Mr. William Williamson

It is in the tradition of British natural history that the only monograph on the water-mites of this country—the Ray Society's three volumes on "The British Hydracarina"—should have been written by two amateur naturalists, C. D. Soar and William Williamson. Williamson, born in Leith in June 1869, was during practically the whole of his working life a clerk, and latterly chief clerk, in the Scottish American Mortgage Company in Edinburgh. His interest in natural history began fortuitously, on

account of his discovery, in the course of miscellaneous reading, of a series of articles describing British water-mites which appeared in *Science Gossip* in 1899 and 1900. The author was C. D. Soar, and Williamson, finding that he could easily identify from the detailed descriptions the water-mites he began to collect, got in touch with Soar, so commencing a friendship which lasted until Soar's death, almost forty years later. The contact was in a way a turning-point in his life, for the enthusiasm of one amateur stimulated the other, and Williamson's spare time now became devoted to collecting, identifying and recording hydrachnids.

Williamson published a series of papers, generally in Scottish scientific journals, on his own collecting in various parts of Scotland, identified the collections made during Murray and Pullar's "Survey of Scottish Fresh-water Lochs", revised the early Berwickshire list of Johnston and Dalyell's "Scottish Hydrachnids", and described several new or rare species. But his greatest accomplishment was his joint authorship with Soar of the Ray Society's "British Hydracarina", the three volumes of which appeared in 1925, 1927 and 1928, and the synonymy and detailed descriptions in which were mainly the responsibility of Williamson, while Soar was entirely responsible for the skilled and beautiful illustrations.

Like Soar, Williamson was "an ardent field worker and an accomplished microscopist", a shy and modest man, who, although ill-health clouded his latter years, remained interested in his books—for he was an omnivorous reader—and in his water-mites until his last illness. He died in Edinburgh on December 19, 1950, at the age of eighty-one, his wife having predeceased him by a few months.

JAMES RITCHIE

Mr. H. Y. Oldham

HENRY YULE OLDHAM was the son of Thomas Oldham, F.R.S., sometime director of the Geological Survey of India, and was educated at Rugby and at Jesus College, Oxford. After taking his degree he was for a time tutor to the Duc d'Orleans, and was always proud of the memory. He studied for a time in Paris, and, after some years of experience as an assistant master, first at the Hulme Grammar School in Manchester, then at Harrow (where Mr. Winston Churchill had been among his pupils), he spent a year of advanced study in geography in the University of Berlin.

In 1892 Mr. Oldham became a lecturer at Owens College, Manchester, and in the following year took up the lectureship created by the Royal Geographical Society for the encouragement of geographical studies at Cambridge. This he held with success for five years, after which he was promoted to the readership, which he held for ten years, from 1898 until 1908.

Mr. Oldham's death on March 14, at the ripe age of eighty-eight, breaks a link with the days when geography was not regarded generally as a scientific study, and when very little was done in schools or at the universities to foster interest. There are probably very few now living who remember Oldham in his prime, the pioneer whose enthusiasm drew large audiences, not so much at Cambridge as in the great manufacturing towns of the north of England, where his discourse—racy, anecdotal, scarcely perhaps by modern standards systematic enough to pass as academic—kindled an interest in such mysteries as the measurement of the curvature of the earth, and still keener interest in the story of the sailors and explorers who opened up the New World by their curiosity and courage. Oldham loved those tales, and had the natural and infectious eloquence which kindled the imagination of his hearers. This pioneer work, more than the papers he contributed occasionally to a learned journal, gave him his best title to remembrance as a geographer.

At Cambridge, Oldham is best remembered as the founder and for many years the 'Commodore' of a highly successful undergraduate cruising club. Many young men owed to him their love of sailing and of ships, and he was happy in the thought that in the First World War so many young men in the Navy did good service as the representatives of the cruising club which had been his and their delight in peace-time. There was no guile in Oldham. His was a gentle, friendly nature, and many of the younger generation at King's College, where he resided as a member of the High Table for just half a century, though they know little or nothing of his pioneer work for geography, will long remember him with warm affection.

J. T. SHEPPARD

Dr. Helmuth Lissner

DR. H. LISSNER died at Haifa on February 15 of heart disease, and his passing came as a profound shock to his many friends in Great Britain, who admired his work as a fishery scientist and who loved him as a companion.

Lissner was born at Thorn in Prussia in December 1895. In 1916 he entered the University of Leipzig to study biology and natural history, and in 1920 he was employed at the biological station at Heligoland. In the following year he became assistant to Prof. Meisenheimer at Leipzig, and in 1922 he took the degree of doctor of philosophy and then joined Prof. Ehrenbaum, as assistant, in the Deutsche Wissenschaftliche Kommission für Meeresforschung in Hamburg.

There Lissner began his real fishery work, most of which was concerned with the study of the great German herring fishery, both from the biological and commercial points of view. Between 1922 and 1933 he published many papers on his subject, and he was rapidly becoming an accepted expert in fishery science when the upheavals of the Third Reich forced him to leave Germany and go to England.

From February to November 1934 he worked at the Laboratory of the Marine Biological Association at Plymouth; then he took up an appointment with the Turkish Government in Istanbul. On the termination of this contract he went to the Institute of Marine Biology at Rovigno, but again left just before Italy entered the War. His next move was to the Philippines, where his brother was living, and once again he began work at a fisheries institute there, but he did not wish to stay after the War when he was offered a permanent post in fisheries.

Lissner finally settled in Palestine, where he succeeded, amid countless difficulties, in establishing a new Fisheries Institute with several departments, but he did not live to see the programme completed. His last wish was to be buried at Cæsarea near the site of the new Institute.

W. C. HODGSON

WE regret to announce the death of Prof. A. Sommerfeld, For.Mem.R.S., sometime professor of theoretical physics in the University of Munich, which occurred on April 26.

MESSAGE FROM THE LORD PRESIDENT OF THE COUNCIL TO *NATURE*

WE are sometimes told that ordinary men and women have not as good an appreciation as they should have of the advantages of science and of the fuller use that might be made of them by the community. There may perhaps be some justice in this suggestion; but I think it is fair to say that people in general are anxious to know, but often find it difficult to understand, the technical terms generally used in these matters.

To whatever extent that may be true, there will be unprecedented opportunities during this summer, in connexion with the exhibitions organized during the Festival of Britain, for people to obtain a better understanding and appreciation of what science and scientists are doing.

During the coming season, there will be Exhibitions of Science at South Kensington and of Industrial Power at Kelvin Hall, Glasgow, and similar exhibitions will occupy an essential place in the South Bank Exhibition as well as in the Festival Ship *Campania*. There will also be Exhibitions of Architecture, Town Planning and Building Research at Lansbury.

The Exhibition of Books in the Victoria and Albert Museum also has its historical science section. The National Physical Laboratory and other leading scientific institutions will be opening their doors to visitors on various occasions, several important international congresses of scientists and engineers are being held in Great Britain, and special sessions are being arranged by a number of learned societies.

Great effort and considerable expenditure have gone into these projects, and I am confident that they will reach a high standard. My purpose in writing this message is to invite the support of scientists generally in backing up this initiative in their own particular sphere, and in doing all they can, both collectively and individually, to assist laymen to understand and appreciate what they are doing.

We may confidently hope that these important demonstrations arranged in connexion with the Festival of Britain will lead to some lasting improvement in the relationship between science and the community and in the wider adoption of scientific methods and discoveries. The more help scientists themselves are able to give with this aspect of the Festival the better its results will be.

May I also, as Lord President, take this opportunity of recognizing the invaluable help given by a large number of eminent scientists in deciding on the content of the scientific displays and in bringing them into existence.

ADDISON

April 26, 1951.

NEWS and VIEWS

New Foreign Members of the Royal Society: Prof. Herbert M. Evans

PROF. HERBERT MCLEAN EVANS began his scientific career nearly fifty years ago as an embryologist; but for more than forty years he has exerted a dominating influence in many different aspects of experimental biology, and particularly in endocrinology. His earliest contributions (1904) were anatomical and embryological in interest, and right at the beginning he made important and now classical contributions to the study of vital staining. The introduction of the dye, now known as Evans's blue and still extensively used for the estimation of fluid volume in the animal body, was of particular importance. Prof. Evans's embryological investigations led him to study the ovary, to which organ he applied the methods of vital staining. This led, in 1920, to the study of the œstrous cycle in the rat, which he was the first to describe, and to an investigation of reproductive physiology in general. The inception in 1921 of a series of publications in collaboration with J. A. Long, concerning the influence of the administration of extracts of the thyroid and anterior pituitary glands on the reproductive function in the rat, marks the beginning of Prof. Evans's interest in general endocrinology. This quickly led, in 1922, to the recognition of the growth hormone of the anterior pituitary lobe, and also provided a clear demonstration of the presence of gonadotropins in that lobe. In the same year, investigations were begun on the relationship between fertility and nutrition, which immediately led to the recognition of a hitherto unrecognized dietary factor essential for reproduction, later called vitamin E. During succeeding years the separation one from another of anterior pituitary hormones, the purification of vitamin E and the influence of different vitamin deficiencies on reproductive activity, were all under investigation by Prof. Evans and his colleagues, and the isolation of α-tocopherol (vitamin E) in collaboration with O. H. and G. H. Emerson was announced in 1936.

In more recent years Prof. Evans has concentrated, in collaboration with C. H. Li and others, on the isolation and characterization, both chemically and biologically, of anterior pituitary hormones, and as a result there have come from his laboratory four protein hormones, the properties and nature of which are still actively under investigation. For thirty years Prof. Evans has exerted an influence in practically every major advance in the fields of reproduction and anterior physiology. Since 1930 he has been director of the Institute of Experimental Biology in the University of California, and there he has developed and directed a large school of vitally active research which still retains a leading position in endocrinology, and through which a steady stream of first-class research workers continues to flow.

Prof. K. S. Lashley

PROF. K. S. LASHLEY holds a chair of experimental psychology at Harvard and at the same time directs the studies of animal behaviour at a large anthropoid colony in Florida. He is one of the foremost authorities in the world at present concerning the neurological basis of animal behaviour. He has conducted a series of experimental studies dealing principally with the establishment of visual and motor habits in rats under controlled conditions. In 1929 his general conclusions were published in the

book entitled "Brain Mechanisms and Intelligence", which has had a profound effect upon technique and interpretation in this field. In the rat, Lashley showed that quite large areas of cortical activity have to be regarded as equivalent and equipotential for all processes of simple learning, and that for more complex learning the same kind of equivalence may be demonstrated in less extended areas. His recent work has been concerned with primate behaviour, in particular with recognition and recall in the chimpanzee. Here, too, he finds a type of areal, or regional cortical localization for functions of great complexity, but with equivalence within the fairly large areas concerned. Lashley is an experimental psychologist who has never become wedded to a particular theoretical approach, and his critical attitude to his own and to other people's views has had a most salutary influence on the development both of brain physiology and of animal behaviour studies.

Prof. Carl Størmer

Prof. Carl Størmer long held the chair of pure mathematics at the University of Oslo. His mathematical work deals mainly with the motion of electrically charged particles projected (singly) into the field of a magnetic dipole. These researches were originally undertaken to develop and check Birkeland's theory of the aurora and magnetic storms. The results show many important resemblances to auroral phenomena, and seem likely to find a permanent place in the true auroral theory which is yet to come. These researches also found another important field of application to cosmic rays as influenced by the earth's magnetic field. Størmer has also for several decades been a pioneer, leader and organizer of auroral observation. By simultaneous photography from two or more places he has observed and measured hundreds of auroras against the stellar background, determining the form and location (height and geographical situation) of the auroral luminosity. He has discussed statistically and otherwise a vast body of such data. One of his outstanding discoveries is that exceptionally high auroras, sometimes reaching up to 700 km. or even more, lie in regions traversed by sunlight, though seen from the ground at night. He has also made important contributions to our knowledge of the auroral spectrum. Størmer has seized every opportunity afforded by Nature for the observation of other atmospheric phenomena, such as long-enduring meteor trails and the mysterious mother-of-pearl clouds. Thus he combines in an exceptional way the abilities of a mathematician and an observer of Nature. He has exploited to the full, with great skill, energy and success, the opportunities for auroral observation afforded by the geographical situation of Norway.

Dr. R. W. G. Wyckoff

R. W. G. Wyckoff began his scientific work as a physicist, applying the theory of space groups to the determination of the structure of crystals. Later he turned his attention to different applications of physics to biological problems. His first biophysical work, carried out at the Rockefeller Institute, provided quantitative studies of the effects of radiation (X-rays, electrons, ultra-violet light) on micro-organisms, interpreting the results in terms of 'the sensitive volume' theory. Wyckoff's attention was next turned to the possibilities of the air-driven ultra-centrifuge for molecular sedimentation. Still at the Rockefeller Institute, in conjunction with Bauer and Pickels he developed this instrument and made the first air-driven analytical ultra-centrifuge. As a result of his experiments on the sedimentation of substances of high molecular weight, Wyckoff's interest in viruses was aroused, a subject to which he has made great contributions. Using his air-driven ultra-centrifuge and working in conjunction with Stanley and others, he succeeded in isolating several viruses. Arising out of these investigations was the important work of making antivirus vaccines, and he produced (with J. W. Beard) the embryo-propagated encephalomyelitis vaccine. This was especially important at the time because it was the first successful heterologous 'killed' antivirus vaccine. These methods were then developed and applied successfully to making this vaccine in the first large-scale production of an embryo-grown vaccine. More recently, as a consequence of his development (with R. C. Williams) of the metal-shadowing technique, Wyckoff has been applying electron microscopy to the study of macromolecules of biological importance, especially viruses. It is in his handling of the electron microscope that Wyckoff has shown himself a master. His main lines of work with the electron microscope have been the study of the molecular arrangements in solids: in this respect may be recalled the demonstration of the particles of tobacco necrosis virus and their arrangement on the crystal faces (first published in *Nature*); the recognition of viruses within infected cells and the application of this recognition to the continuing study of how viruses, including bacteriophages, multiply. His latest work is the examination by electron microscopy of sections of virus-infected insects; this is the first time such a technique has been used, and it has already yielded some interesting and important results.

Royal Society of Arts Prize of £500

In July 1950, the Royal Society of Arts, as part of its celebrations of the centenary of the Great Exhibition of 1851, which it originated, and as a constructive effort to assist the nation in its present difficulties, offered a prize of £500 and a gold medal for "a means of promoting the production or the economic utilization of food in Britain". This prize has been awarded to Dr. R. E. Slade, farmer, of Bishop's Stortford, Herts, during 1935–45 controller of research, Imperial Chemical Industries, Ltd., who submitted a scheme for two systems of farming, one for grassland and the other for arable land. A silver medal was also awarded to the runner-up, Mr. R. M. Paterson, of Basingstoke, Hants, for his simple system of grassland recording. There were a hundred and fifteen entries for the competition.

Exhibition of Exhibitions

An "Exhibition of Exhibitions", covering nearly two hundred years of British initiative in the art of display, has been organized by the Royal Society of Arts at its headquarters, John Adam Street, Adelphi, London, W.C.2, and was opened on May 1 by H.R.H. Princess Elizabeth. Besides its greatest triumph, namely, the initiating of the Great Exhibition of 1851, the Royal Society of Arts has been responsible for many other pioneer efforts in a similar vein: in 1760 it sponsored an exhibition of contemporary art, and in the following year it held an industrial exhibition, probably the first one of its kind in the world. Two other historic exhibitions which are recorded are the series on industrial design, which

was shown during 1847–50, and the photographic exhibition of 1852. Dealing with the more recent past, there are displays of the British exhibitions of 1935 (British Art in Industry) and 1946 ('Britain Can Make It'). The "Exhibition of Exhibitions" will be open daily until September 25 (Sundays excepted) from 10 a.m. to 6 p.m. (Wednesdays, 8 p.m.), and the admission fee is: adults, 1*s.*, children, 6*d.*

Exhibition of the Development of British Maps and Charts

During the Festival of Britain the Royal Geographical Society will be holding an exhibition at the Society's headquarters, 1 Kensington Gore, London, S.W.7, which will illustrate the development of British maps and charts and the many different ways in which cartography is used in the modern world. Among the exhibits will be the newly discovered Molyneux globe of 1592, the first globe to be made in England, and the physical globe made by Dr. Keith Johnston, which was shown at the 1851 Exhibition. There are displays from the Admiralty Hydrographic Department, Ordnance Survey, Air Ministry, Ministry of Civil Aviation and the Ministry of Local Government and Planning. In addition to a number of technical lectures on cartography, the Society will show on May 21, at 8.15 p.m., two famous films of British exploration: the 1922 assault on Mount Everest and Ponting's contemporary film of Scott's last expedition to the Antarctic. A limited number of seats for these films will be available to the general public on application to the Society. The exhibition is open to the public and will be shown from May 3 onwards (Monday–Friday, 10 a.m.–5 p.m.; Saturdays, 10 a.m.–1 p.m.).

Holiday Camp at the British Association Meeting

To help the younger generation to take part in the proceedings of the British Association, an experiment is being tried at the Festival Year meeting in Edinburgh. It is an attempt to combine an open-air holiday with facilities for attending the discussions and for meeting the experts. The Workers Travel Association has provided facilities at the Broomlee Camp, West Linton, eighteen miles south of Edinburgh, where there is dormitory accommodation for two hundred visitors. The Edinburgh Committee of the British Association is allocating fifty free membership tickets for the use of the visitors, so that one-quarter of them each day will be able to sample the discussions. Those who want to attend all the meetings can become local members for £1 1*s.* and students for 10*s.* 6*d.* In addition to opportunities for attending selected discussions, arrangements are being made for scientific workers from the Association meeting to visit the camp in the evenings for lectures and demonstrations.

This experiment recognizes the difficulties which young people interested in science may have in choosing between a holiday and a scientific event such as the British Association. This combination, which will cost £3 10*s.* a week, will provide both. The camp itself has twenty-five acres of gardens and playing fields in the foothills of the Pentlands, with plenty of opportunity for outdoor activities and excursions. The general arrangements for this special holiday-with-a-purpose will be supervised by Mr. Ritchie Calder, member of the Council of the British Association and science editor of the *News Chronicle*. Bookings can be arranged through the Workers Travel Association, Eccleston Court, Gillingham Street, London, S.W.1.

Professional Engineers Appointments Bureau: Activities during 1950

The Professional Engineers Appointments Bureau, an organization which exists mainly for the placing of members of the Institutions of Civil, Mechanical and Electrical Engineers in suitable positions of employment, has recently reviewed its activities during 1950. The average number of engineers on the register was 471, as compared with 462 during 1949, and the total registrations to the end of the year was 1,947, of which 468 were civil, 924 mechanical, and 555 were electrical engineers. The main work of the Bureau has been concerned with engineers who are already in employment, and the majority of those unemployed are more than forty-five years of age. The real shortage is of first-rate engineers, particularly those with highly specialized experience and with outstanding academic qualifications. The number of notifications of vacancies from employers was 1,111, of which 335 were for civil, 510 for mechanical and 266 for electrical engineers. A considerable proportion of the overseas vacancies were for the Middle and Far East, India and Pakistan, and there was some difficulty in finding persons willing to go to these countries. There is always a steady demand from engineers for employment in Canada, Australia, South Africa and Europe, but, in general, few vacancies are notified from these countries; employers usually require engineers with specialized experience, and the shortage of such specialists is world-wide. In Great Britain a major difficulty in placing engineers is the acute housing shortage, which makes people reluctant to leave their present accommodation for the sake of more suitable positions in another part of the country. Other difficulties are that applicants tend to specify minimum salaries considerably in excess of what employers are prepared to offer, and employers on their part tend to demand qualifications which are unnecessarily high for the work in question. More vacancies might be filled if firms were prepared to raise the upper age-limit, though it is realized that there are problems in fitting different age-groups within an organization. The Bureau wishes to know of further facilities for practical training and postgraduate apprenticeships that exist in industry. During the year the Bureau received generous donations from employers; but, as registration and appointment fees are kept very low (£1,047 was received in all), revenue did not cover expenses. It is hoped that further donations will be forthcoming this year. The address of the Bureau is 9 Victoria Street, Westminster, London, S.W.1.

Osiris

The companion volume to *Isis*, organ of the History of Science Society, is *Osiris*, of which vols. 1–7 (1936–39) were published at the expense of the editor, Dr. George Sarton, of Harvard University; then, after the Second World War, vol. 8 (1948) appeared; and the current issue (9; 1950) is published by the generosity of the St. Catherine Press, Tempelhof, Bruges. "The capacity of *Isis* being small," writes Dr. Sarton, "larger papers cannot be included in it without unbalancing the whole. The purpose of *Osiris* is to take care of the larger papers and, incidentally, to pay tribute to the main historians

of science. . . . A set of *Osiris* will thus contain fundamental information concerning the history of our discipline." Past readers of *Osiris*, libraries and members of the British Society for the History of Science, may thus like to be reminded of the resumption of this publication. Vol. 9 illustrates the range covered by the series, from Philip Yampolsky's "Origin of the Twenty-eight Lunar Mansions" and Naum Jasny's "Daily Bread of the Ancient Greeks and Romans", to Gloria McConnaughey's "Darwin and Social Darwinism" and the editor's "History of Science in the Carnegie Institution"; an outstanding paper is E. S. Merton's appraisal of "Sir Thomas Browne as Zoologist". Two items by British scholars in the issue are Joseph Schact's biography of Max Meyerhof and H. W. Jones's "Mid-seventeenth Century Science: some Polemics".

An Unusual Ice Formation

DR. A. MORLEY DAVIES, of Arngrove, Amersham, Bucks, writes to say that he has observed a repetition of the phenomenon of an unusual ice formation which he reported twenty years ago (see *Nature*, **127**, 340 and 603; 1931). "On the morning of February 7, after a frosty night followed by thaw, both the same receptacle as in 1931 and a smaller one of similar shape exhibited a vertical projection, in the form of a triangular prism, from the surface of the ice contained in them. I was only able to take hasty and rough measurements of the smaller one. It occupied an excentric position in a surface of diameter 8 in.; its ground-plan was an isosceles triangle (sides about 1 in., base $\frac{3}{4}$ in.) with a height of more than an inch. As I suspected in the earlier case, it was hollow, the walls being about $\frac{1}{4}$ in. thick. On lifting the whole mass (cake and prism), the hollow was seen to extend down from the top of the prism to the surface of the water below."

"Dielectric Constant and Refractive Index of Air and its Principal Constituents at 24,000 Mc./s."

DRS. L. ESSEN and K. D. Froome write: "In our recent article (*Nature*, March 31, p. 512) we assumed that the permeability of air could be taken as unity in the derivation of values of dielectric constant from measurements of refractive index. This is no longer permissible when the accuracy given approaches 1×10^{-7}, and the expression ε in the article should therefore be replaced by $\mu\varepsilon$. In problems on wave propagation it is this quantity that is required; but in lumped circuit problems μ and ε are required separately. If the value of $(\mu-1)10^6$ is assumed to be 1·9 for oxygen and therefore 0·4 for air, the values of $(\varepsilon-1)10^6$ at N.T.P. become $531{\cdot}0 \pm 0{\cdot}4$ and $576{\cdot}0 \pm 0{\cdot}2$ for oxygen and air respectively. The other results and the extrapolation formulæ are unaffected."

Society of Chemical Industry: Annual Meeting

THE seventieth annual meeting of the Society of Chemical Industry will be held at the Royal College of Science, South Kensington, London, S.W.7, during July 9–13. A special ceremony will take place at 10 a.m. on July 11 at the Royal Institution, Albemarle Street, London, W.1, when the Society's Medal will be presented to Prof. E. C. Dodds, professor of biochemistry in the Middlesex Hospital Medical School, London, and this will be followed by an address by Prof. Dodds on "The Decisive Influence of Chemical Industry in Medicine". The theme of the meeting this year is "Water in Industry", and a number of lectures have been arranged on this topic. Application for tickets to the meeting should be made, not later than May 21, to E. L. Streatfield, London Section, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

Royal Institute of Chemistry: Officers

AT the annual general meeting of the Royal Institute of Chemistry, held on April 27, the following officers were elected: *President*, Mr. H. W. Cremer; *Vice-Presidents*, Dr. G. M. Bennett, Prof. Harold Burton, Prof. J. W. Cook, Dr. W. M. Cumming, Dr. C. W. Herd, Prof. W. H. Linnell and Miss Mamie Olliver; *Hon. Treasurer*, Dr. D. W. Kent-Jones.

Announcements

THE Air Ministry announces that, with the upgrading of the post of director of educational services, Air Ministry, to air vice-marshal rank, Air Commodore A. H. Robson, the present director, has been promoted to the rank of air vice-marshal. Air Vice-Marshal Robson, who was born in 1892, was educated at Gateshead Grammar School, Armstrong (now King's) College, Newcastle upon Tyne, and King's College, University of London, graduating as B.Sc., M.Sc., and Ph.D. He has been associated with the R.A.F. educational service since 1923.

THE Melchett Medal for 1951 of the Institute of Fuel has been awarded to Prof. F. H. Garner, director of the Department of Chemical Engineering, and dean of the Faculty of Science in the University of Birmingham. Prof. Garner, who was formerly chief chemist of the Anglo-American Oil Co., is a past president of the Institute of Petroleum and honorary editor of the *Journal* of that Institute.

THE fourth award of the Oliver Memorial Fund (£50) will be made to a British subject for a notable contribution to the research, organization or donor aspect of blood transfusion. Applications and suggestions should be sent, before June 30, to the honorary treasurer, Mr. F. W. Mills, c/o National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

THE 1951 edition of "British Chemicals and their Manufacturers", issued by the Association of British Chemical Manufacturers, 166 Piccadilly, London, W.1, has been entirely revised, and, on application to the Association, copies are available free to persons or firms genuinely interested in the purchase of chemicals.

PROF. MANSON BENEDICT, who was recently made professor of chemical engineering in the Massachusetts Institute of Technology, has also been appointed scientific director of the National Research Corporation, 70 Memorial Drive, Cambridge, Mass. Prof. Benedict is an authority on hydrocarbon thermodynamics and separation processes, and during the Second World War he was in charge of process development for the Kellex Corporation, where he made substantial contributions to the gaseous diffusion process for the concentration of uranium-235. As scientific director of the National Research Corporation he will devote himself initially to a petrochemical research programme which is being undertaken jointly with the Electric Bond and Share Co. and the United Gas Corporation.

ERRATUM. "Britain's Scientific Shrines", April 28, p. 666, col. 1, lines 15 and 16, for "Westminster Bridge" read "Blackfriars Bridge".

COUNCIL FOR THE PROMOTION OF FIELD STUDIES

I. FLATFORD MILL FIELD CENTRE

By P. H. T. HARTLEY
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FLATFORD Mill, the first field centre to be opened by the Council for the Promotion of Field Studies, stands at the tide-head of the Stour estuary in south-east Suffolk. With salt water below the mill sluices and fresh water above, the centre could scarcely be better placed for the study of many aspects of hydrobiology. It is hoped to develop long-term recording of some of the hydrological conditions, including that curiously neglected subject, temperature changes in a slow-flowing river.

The very limited fauna of the estuarine habitat, and the violently fluctuating environmental conditions, make an estuary one of the best training grounds for ecological research, second only, perhaps, to barren desert. The student is not faced with the overwhelming variety of forms which can be so daunting to the worker in such habitats as woods and hedgerows. In addition, the contained macrofauna of tidal mud is probably as amenable to accurate quantitative survey as any community in the world. It is therefore possible to offer investigations to the relatively inexperienced biologist in which he is able to feel that he can make a real contribution to knowledge. These investigations are in happy contrast to mere 'exercises' almost wholly valueless on account of sampling errors or difficulties of technique. The many estuaries of the east coast of Britain offer a variety of hunting grounds where the comparison of similarities and the contrast of differences offer material for ecological speculation and guidance in ecological experiment. It is hoped that field observations will be linked increasingly with laboratory experiment. Instruction in sampling methods may also give the first (perhaps bitter) lesson that ecology is as much an affair of the slide-rule and the study lamp as of the woodland ride and the boat on the tideway.

On the botanical side, the immediate neighbourhood of the Mill is already the scene of research into the changes in the floras of dykes and grazing marshes in conditions of decreasing salinities following reclamation work in the upper reaches of the estuary. On the Suffolk coast, the ridges at Shingle Street are also under observation, and records are being made of the succession of vegetation on the ridges, with the steady increase in the number of species on each ridge from the sea's edge inwards, and the correlations between the age of the ridges and the flora thereon. At Shingle Street there are a number of interesting

Flatford Mill Field Centre

[*Photo: E. Dudley C. Jackson*

lagoons, in close contiguity but differing considerably in hydrology, flora and fauna.

The very rural surroundings of the Field Centre, where some acres of orchard and meadow are under the control of the Council, are well suited for studies in the biology of many species of birds. It is proposed to make special studies of the life-histories of a few common species. Visiting workers will find birds of these species already colour-ringed and so individually recognizable. The technique of field experiment will also, it is hoped, be much used, with special reference to problems of perception, recognition and sign stimuli.

The major interests of the Centre have been briefly discussed; but it is hoped to avoid any undue specialization, and gradually to accumulate such a record of the fauna and flora of the locality as shall provide a synoptic view of the potentialities of the area to visiting research workers in many groups and subjects. It is felt that only if there be many and frequent visits from serious naturalists (and in the country of Charles Darwin it is to be hoped that many of them will always be amateurs) will the Centre be able to claim that it is, indeed, promoting field studies.

Contributions to knowledge, by the Centre's own research programme and by assistance to visiting biologists, must ever have pride of place in the interests of Flatford Mill. Besides this, it has an important educational function to perform among undergraduates and senior pupils of schools. The educational side is inspired by the belief that natural history can provide that foundation in the art of inductive thinking which cannot be obtained from physics and chemistry as taught in schools. In the study of animals and plants there are few certainties, and the pupil can only be told what he may find. Nor is failure to make the discovery a proof of incompetence or sloth. In school physics the correct answer to each experiment described is printed at the back of the text-book, with a resulting temptation to 'adjust' the figures in the note-book. Again, in natural history, the subjects of study have no neat labels attached as have the bottles of chemicals in the school laboratory, and the end-product of an experiment cannot be identified deductively.

It is hoped to make the concept of natural selection the centre of all biological teaching. The student will be encouraged to review each discovery in terms of relation to the environment, and constantly to speculate on the nature of the adaptation—the contrasts of the most perfect and the least imperfect fitness. The occupation of ecological niches will be considered not only in terms of structural adaptation, but also in the presence or absence of extra-specific competitors. By such means it is hoped to emphasize that natural selection is a present, active and urgent force, and not only something immeasurably antique which long ago shaped the amphibians of the Devonian and the dinosaurs of the Trias.

Since many students attending courses come from urban environments, it is hoped to give them a glimpse of the autonomy of country interests and of the inflexible rhythm of seasonal changes on which all human life depends. The review of the myriad small, complex and intricately connected lives moving in the sunshine of a summer's day may bring a realization that the world was not, after all, made by the local education authority. Perhaps the final lesson of all natural history is that "God hath upon Him a terrible majesty".

THEORY OF SORPTION COLUMNS

THE recent communications on theory of sorption columns[1] by Sillén and by Ekedahl, Högfeldt and Sillén direct attention to the excellent Swedish work in this field, which has not hitherto been as well known to workers in Great Britain (including myself) as it deserves. Probably unintentionally they have, however, given the impression that their work represents the latest stage in the development of this theory.

The use of v/x as a variable, now named the 'ψ-condition' by Sillén, goes back to Wilson[2], DeVault[3] and Weiss[4], who described the phenomena leading to Sillén's equations (2) and (3) in full detail, and it has been extensively employed in discussions of the column behaviour of single solutes of all types of isotherms[5a]. The integration of the equation $dq/dc = v/x$, with several solutes simultaneously present, using both specific and general isotherms[5b,5d,6-8] has given an almost complete picture of what can happen in an 'ideal' chromatographic column, both for development and displacement[9] analysis. In these treatments the term v/x receives its full share of importance. But it is also apparent that the v/x term, while affecting the position of the boundaries, does not always give information on where these boundaries begin and end, and other factors have been taken into account as well in order to complete the picture.

The application to ion-exchangers[5a,5b,10,11] and the phenomena occurring in non-equilibrium processes[5c,12] have been described more realistically than by Sillén's equations (9) and (10), which give symmetrical S-shaped boundaries (see his Fig. *c*) for a Langmuir isotherm, whereas experiments with ion exchangers[5c,10] give an asymmetrical S-shape which has been theoretically explained[5c,12]. The reason for this discrepancy is that Sillén[13] implicitly assumes the reaction-rate as the rate-determining factor, whereas in non-gaseous systems the rate is invariably controlled by diffusion[14,15].

A full appreciation of the papers mentioned above and of others quoted in ref. 12 leaves the impression that practically every aspect of column theory is now known or can be dealt with, with the exception of the effect of non-equilibrium and other disturbing factors on the shape of ideally diffuse boundaries, for which cases the differential equations do not permit of a general solution. We can therefore expect little further development of column theory, apart from simplifications by neater mathematics or by useful approximations.

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[1] Sillén, G. L., Ekedahl, E., and Högfeldt, E., *Nature*, **166**, 722 (1950).
[2] Wilson, J. N., *J. Amer. Chem. Soc.*, **62**, 1583 (1940).
[3] DeVault, D., *J. Amer. Chem. Soc.*, **65**, 532 (1943).
[4] Weiss, J., *J. Chem. Soc.*, 297 (1943).
[5] Glueckauf, E., and Coates, J. I., *J. Chem. Soc.*, (*a*) 1302; (*b*) 1308; (*c*) 1315; (*d*) 1321 (1947).
[6] Glueckauf, E., *Proc. Roy. Soc.*, A, **186**, 35 (1946).
[7] Glueckauf, E., Farad. Soc. Discuss. No. 7, 12 (1949).
[8] Davidson, B., Farad. Soc. Discuss. No. 7, 45 (1949).
[9] Claesson, S., Farad. Soc. Discuss. No. 7, 34 (1949).
[10] Duncan, J. F., and Lister, B. A. J., *J. Chem. Soc.*, 3285 (1949).
[11] Duncan, J. F., and Lister, B. A. J., Farad. Soc. Discuss. No. 7, 104 (1949).
[12] Glueckauf, E., Barker, K. H., and Kitt, G. P., Farad. Soc. Discuss. No. 7, 201 (1949).
[13] Sillén, G. L., *Arkiv för Kemi*, **22A**, No. 15, 13 (1946).
[14] Boyd, G. E., Adamson, A. W., and Myers, L. S., *J. Amer. Chem. Soc.*, **69**, 2836 (1947).
[15] Kressman, T. R. E., and Kitchener, J. A., Farad. Soc. Discuss, No. 7, 90 (1949).

We were interested to read of the success of Ekedahl, Högfeldt and Sillén in determining the separation factors of the silver–hydrogen exchange reaction from the elution boundaries obtained when a solution containing hydrogen ions is allowed to percolate through a column of a silver-saturated exchanger[1]. It was DeVault[2] who first pointed out (in different symbols) that equation (5) of the paper by Ekedahl, Högfeldt and Sillén permitted the calculation of adsorption equilibrium data from elution boundaries. His equation has been further developed[3] to give accurate equilibrium values even if the column is operated under non-equilibrium conditions. The improved method has been used[4] for determining the separation factor for the sodium–hydrogen exchange on 'Dowex-50', and the accuracy obtained compared favourably with that of other methods. This was also the conclusion of Ekedahl *et al.*

Although this method is applicable in theory to the determination of any exchange equilibrium, it is not experimentally as straightforward in all cases as the recommendation of Ekedahl *et al.* suggests. When a multivalent ion (for example, Ba^{2+}, La^{3+} or Th^{4+}) is eluted with a monovalent ion (for example, H^+ or Na^+), the concentration of the multivalent ion in the eluate falls very sharply from its initial value. Thus, even in the case of elution of the relatively weakly absorbed Cu^{2+} with $N/5$ H^+ from a column of 'Dowex-50', the ionic concentration of Cu^{2+} falls to about 10^{-3} molar, while the exchanger is still only about two-thirds converted to the hydrogen form[5]. In such cases we prefer to use the batch technique for accuracy.

Ekedahl *et al.* have also confirmed that the separation factor for an ion exchange reaction depends on the fraction of the two ions in the exchanger. This has often been reported since about 1918 for inorganic exchangers[6], and since 1948 for exchangers of the synthetic resin type[7]. We ourselves have observed it on 'Dowex-50' with the following pairs of exchanging ions[4,5,8]: Na^+/H^+; Ba^{2+}/H^+; La^{3+}/NH_4^+; Zn^{2+}/UO_2^{2+}; Ag^+/H^+; and Cu^{2+}/H^+. The phenomenon is now so general that any theory of ion exchange must adequately account for it.

An attempt has been made[9] to explain such ion exchange behaviour on a thermodynamic model which takes into account the volume changes occurring when the ionic content of the exchanger is changed. However, this treatment does not allow adequately for the changes in the activities of the ions inside the exchanger. By treating an exchanger as if it were a concentrated aqueous electrolyte, we have been able to show that the activities of the ions inside the exchanger are in many instances more important in determining ion-exchange behaviour than the mere change in the exchanger volume. We have calculated, for example, the activity of the water inside a sodium-saturated exchanger from the observed amount of neutral salt which is taken up by the exchanger in solutions of sodium iodide and bromide, the observed water-contents of the exchanger, and the osmotic coefficients of sodium iodide and bromide in the aqueous solution obtained from tables. The osmotic coefficient of the pure sodium 'resinate' in different total molalities could thus be calculated, and the same values were obtained whether the sodium iodide or sodium bromide data were used.

By the reverse process, we have also calculated what the osmotic coefficient of aqueous sodium chloride solutions would be in 8–12 molar concentration (if such solutions existed), and again the calculated data seem to agree with what would be expected from an extrapolation of the data given in tables for lower concentrations. We have also recently investigated how far this treatment can be applied quantitatively to the more difficult case of a pair of exchanging ions, and we conclude that, in this case, ionic interaction differing from that observed in purely aqueous solutions must play an important part in determining the shape of the adsorption isotherm. We suspect that this difference arises from the slightly ordered arrangement of negative charges in a cation-exchanger, so that the energy-level of a cation depends on the nature of its nearest neighbours. There will also be an effect from the competition of different types of cations for the limited amounts of hydration water. Either case could cause the observed increased deviation from ideality with increased cross-linking and decreased swelling ability. This work will shortly be reported in detail.

We thank the Director of this Establishment for permission to publish this note.

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[1] Ekedahl, E., Högfeldt, E., and Sillén, L. G., *Nature*, **166**, 723 (1950).
[2] DeVault, D., *J. Amer. Chem. Soc.*, **65**, 532 (1950).
[3] Glueckauf, E., *J. Chem. Soc.*, 3280 (1949).
[4] Duncan, J. F., and Lister, B. A. J., *J. Chem. Soc.*, 3285 (1949).
[5] Duncan, J. F., Brown, P., and Dinham, M. (forthcoming publication).
[6] Rothmund, V., and Kornfeld, G., *Z. anorg. allgem. Chem.*, **103**, 129 (1918).
[7] Davidson, A. W., Argersinger, W. J., Stoenner, R. W., and Lowen, W. K., Tech. Report, Office of Naval Research, N.R. 057158 (1949). Pepper, K. W., Reichenberg, D., and McCauley, D. J., *J. Chem. Soc.*, 493 (1951). Strickland, J. D. H., Farad. Soc. Discuss. No. 7, 157 (1949). Marinsky, J. A., and Coryell, C. D., Office of Naval Research, N.R. 026001 (1949). Duncan, J. F., and Lister, B. A. J., *Chem. and Indust.*, 26 (1949); Farad. Soc. Discuss. No. 7, 156 (1949).
[8] Duncan, J. F., and Lister, B. A. J., Farad. Soc. Discuss. No. 7, 104 (1949).
[9] Gregor, J., *J. Amer. Chem. Soc.*, **70**, 1293 (1948), and **73**, 642 (1951).

What we have tried to find is rather "neater mathematics" and "useful approximations", to quote Dr. Glueckauf. Since our communications appeared[1], we have published some papers[2–7] which we hope will explain our points more fully than was possible in two short communications or in this brief comment. In these papers, incidentally, we have tried to pay due regard to previous work, and refer to most of the papers quoted by Drs. Glueckauf and Duncan.

The 'ψ condition' is, of course, contained in the earlier work quoted by Dr. Glueckauf. Our point is, however, that by sticking to it consistently and using a graphical representation with V–x diagrams, equilibrium processes in sorption columns can be described very simply and clearly. This approach has been applied to a number of cases[2]; the diagrams really seem to afford considerable help in finding out where the boundaries begin and end.

Another point is that the best approach to non-equilibrium processes in sorption columns seems to be first by considering the corresponding equilibrium process[3]. Where a sharp front would have been formed at equilibrium, it can be shown[2,3] that a 'final form front' is obtained under non-equilibrium conditions. Unfortunately, most current kinetical approaches to sorption columns, except those of Johansson *et al.*[11], ourselves[9,10], and Glueckauf[12], either

do not lead to or, if they do, do not emphasize the important phenomenon of the final form front.

For describing the form of the final form front in a simple ion exchange process, we have used equation (10) of ref. 1 (essentially identical with equation (9) in ref. 9, equation (4) in ref. 10, equation (26) in ref. 3, and equations (2) and (3) in ref. 1*b*). In the derivation of this equation we have knowingly made use of an artifice: we have "replaced the complicated diffusion and sorption process by a bi-molecular reaction"[10]. The only justification for such an artifice is if the resulting equation proves a "useful approximation". We have applied this equation to our measurements of the replacement of hydrogen ions by silver ions on an ion exchanger, where the concentration of silver ions could be measured down to less than 10^{-6} *M* by an electromotive force method. These measurements still give perhaps the most accurate leaking curves recorded. Actually, equation (10), unrealistic as it may be, fitted in surprisingly well with the results[9,10].

However, there may be cases where equation (10) fails and other equations would describe the observations better.

The other main type of front is the broadening front ("ideally diffuse front" of Dr. Glueckauf). For non-equilibrium conditions we agree with Dr. Glueckauf that it is hard to find a general solution. However, it can be shown[3] that with increasing V and x, the functions $q_i(\psi)$ and $c_i(\psi)$ will approach indefinitely to the corresponding curves for equilibrium, which are unambiguously given by the isotherm. The relation between the non-equilibrium and equilibrium processes is stressed by describing the former by means of 'false isotherms' or the equivalent 'false $\varkappa(\beta)$ curves' as the ones given in Fig. 1 of ref. 1*b* and discussed in ref. 3. This may prove a convenient and compact way of representing data and even an aid in making quantitative predictions with useful approximation.

We agree with Drs. Duncan and Glueckauf that we may have become over-enthusiastic about the method of calculating sorption isotherms from continuously recorded broadening fronts. Admittedly the silver ion is very suitable for this method, since its concentration can be measured continuously and accurately down to very low values, using specially treated silver electrodes. However, we presume that concentrations of Cu^{2+} considerably lower than 10^{-3} *M* might also be measured continuously and accurately, using properly treated electrodes. One might also think of other continuous methods, such as adding a colouring agent like ammonia to the outflow solution and measuring the extinction for a suitable wave-length. The radiometric method unfortunately does not seem to have quite the accuracy and speed one might desire from a continuous flow method. In cases where no continuous method can be contrived, one must, however, resort to analysing fractions of the solution, which would involve an amount of work comparable to that of analysing batches, and thus offer no real advantage over the batch method.

Our measurements of the silver – hydrogen exchange equilibria[1] have been published in the *Acta Chemica Scandinavica*[7]. The variation of the equilibrium quotient for the ion exchanger with the ratio of the ions in the exchanger was certainly novel when our first results were obtained (in the summer of 1948), however well known they may seem now in 1951. It should be noted that this variation is contrary to the fundamental assumptions of most current approaches to the kinetics of ion exchange columns. This may be one reason why such theories fail to describe accurately fronts of the broadening type, especially, for low concentrations of one ion.

We are certainly interested to read Duncan and Glueckauf's references to their approach to the activity conditions in ion exchangers, and shall be glad to learn more about it. In the meantime, we have tried another approach, treating the resin as a solid solution and calculating the activities of the components[4–6]. This leads to some interesting analogies with liquid mixtures which we are studying further.

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[1] (*a*) Sillén, L. G., *Nature*, **166**, 722 (1950); (*b*) Ekedahl, E., Högfeldt, E., and Sillén, L. G., *Nature*, **166**, 723 (1950).
[2] Sillén, L. G., *Arkiv Kemi*, **2**, 477 (1950).
[3] Sillén, L. G., *Arkiv Kemi*, **2**, 499 (1950).
[4] Ekedahl, E., Högfeldt, E., and Sillén, L. G., *Acta Chem. Scand.*, **4**, 556 (1950).
[5] Högfeldt, E., Ekedahl, E., and Sillén, L. G., *Acta Chem. Scand.*, **4**, 828 (1950).
[6] Högfeldt, E., Ekedahl, E., and Sillén, L. G., *Acta Chem. Scand.*, **4**, 829 (1950).
[7] Högfeldt, E., Ekedahl, E., and Sillén, L. G., *Acta Chem. Scand.*, **4**, 1471 (1950).
[8] Sillén, L. G., *Arkiv Kemi*, **22A**, No. 15 (1946).
[9] Sillén, L. G., and Ekedahl, E., *Arkiv Kemi*, **22A**, No. 16 (1946).
[10] Ekedahl, E., and Sillén, L. G., *Arkiv Kemi*, **25A**, No. 4 (1947).
[11] Johansson, C. H., Persson, G., and Svensson, B., *IVA*, No. 200, (1948, 1942).
[12] Glueckauf, E., *J. Chem. Soc.*, 1315 (1947).

COHERENT SCATTERING OF LIGHT BY MONOCRYSTALS AND INTRINSIC BLOCK STRUCTURE

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A THEORETICALLY perfect crystal, in which the particles are strictly arranged in a space lattice, behaves like a homogeneous medium for optical radiation, and thus no coherent scattering of light by such crystals should occur. The thermal movement produces irregular density fluctuations which are equivalent to a certain amount of inhomogeneity. The intensity of scattered light to be expected from this phenomenon can easily be calculated from the theory of density fluctuations. The intensity actually observed of light scattered by real crystals, even if they appear to be perfect specimens, is very much greater than the theoretical value. It must therefore be concluded that real monocrystals possess some sort of 'grain' structure. This may be the result of accidental mechanical imperfections by which the crystal is split up into 'blocks' of a certain size distribution. But such a block structure could also be of an 'intrinsic' nature if, for some reason, a perfect lattice arrangement should become unstable beyond a certain size of block.

Something like an 'intrinsic block structure' of perfect crystals was suggested by Born[1] to account

for certain difficulties in the application of quantum mechanics to the dynamics of crystal lattices. The result of preliminary calculations was that the linear dimensions of these blocks should for most substances have the order of magnitude of 500 atomic distances, and thus be comparable to a vacuum wave-length in the ultra-violet. The original argument which led to this conclusion is no longer considered to be valid by its author (according to a private communication from Prof. Born). Nevertheless, the idea of an intrinsic block structure of this size is supported by considerations concerning the mechanical strength of 'quasi-isotropic solids', the heat conduction in crystals and the melting of solids[2].

As no systematic investigations of the coherent scattering of visible and ultra-violet light by monocrystals seem to have been carried out so far, we have undertaken such an investigation with the aim of getting experimental evidence for a block or grain structure, accidental or intrinsic, in such crystals; for the fraction of the incident-light intensity scattered transversally from a small region of a crystal is a function of wave-length and of the size, shape and mutual relation of the structure elements responsible for the scattering.

The experimental procedure consisted in measuring, by means of an electron-multiplier photocell, the intensity of monochromatic light scattered by natural rock-salt crystals in the range between 6000 A. and 2400 A., and at right angles to the incident beam. Details of the experimental technique, which is rather intricate on account of the very small intensity of the light scattered by perfect specimens, will be published elsewhere in due course.

The theory of light scattering by small particles shows that the scattered light intensity R is independent of the wave-length λ when the scatterers are large compared with λ, and that R is proportional to λ^{-4} (Rayleigh's law) when the scatterers are small compared with λ. For intermediate sizes the shape of the $R(\lambda)$ curves is more complicated, depending also on the form of the scattering particles.

Two crystals from different salt mines have been studied in detail so far. One of them has a uniform distribution of inclusions and scatters twenty times more light than the other. But the function $R(\lambda)$ for this crystal differs from the scattering function of the other crystal only by an additive constant. This shows that the extra light scattered by the inclusions is simply superposed on the light scattered by the crystal proper, and that these inclusions must be large compared with the wave-length. The fact that the intensity of the component dependent upon wave-length of the scattered light is the same function of λ for both crystals and over all parts of each crystal supports the view that it is indeed of an intrinsic nature.

The scattering function for an assembly of insulating spherical particles of radius r, irregularly distributed in a homogeneous medium, has been calculated by Mie[3]. The intensity at right angles is found to be proportional to

$$R = nr^2P(\alpha,\mu), \qquad (1)$$

where n is the number of particles per unit volume and P a function of the relative refractive index μ of the particles and the medium, and

$$\alpha = 2\pi r/\lambda, \qquad (2)$$

λ being the wave-length in the medium. For $\alpha < \frac{1}{2}$ one has approximately

$$P \sim \left(\frac{\mu^2-1}{\mu^2+2}\right)^2 \alpha^4, \qquad (3)$$

that is, Rayleigh's law holds when the diameter of the particles is smaller than about one-sixth of the wave-length. For other values of α (between 0·5 and 6) and μ (between 1·33 and 1·55) P has been tabulated[4]. Fig. 1 is a graph of $\log_{10}P$ plotted against $\log_{10}\alpha$ for $\mu = 1{\cdot}33$. The reduction to the fourth-power law for small α is seen; but in addition the two maxima at $\alpha = 1{\cdot}8$ and $\alpha = 3{\cdot}8$ should be noticed.

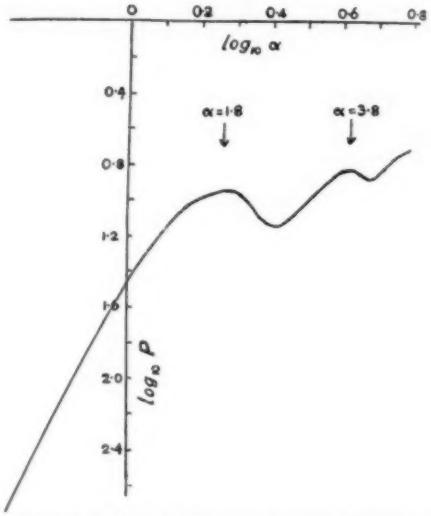

Fig. 1. Theoretical scattering curve for spherical particles

The explanation of these maxima is, roughly speaking, that the particles act as 'resonators', and that abnormally high scattering will occur when the frequency of the primary radiation coincides with one of the normal modes of vibration of these resonators. The first maximum at $\alpha = 1{\cdot}8$ corresponds to the fundamental frequency of the resonator and the second maximum to the first 'overtone'. This should occur when μ/λ is approximately twice the value for the fundamental which would correspond to $\alpha \doteq 3{\cdot}6$; the correct value is 3·8.

Assuming that the effect of the supposed grain structure of a real crystal is, to a first approximation, equivalent to that of an assembly of spherical scatterers, we can estimate the size of the grains by comparing the theoretical scattering curve $R(\lambda)$ with the observed one.

In our experimental observations we always find a pronounced maximum of R at a value $\lambda = 4030$ A. which corresponds to a vacuum wave-length of 6300 A. at the red end of the spectrum. We have not yet extended our observations into the infra-red, so as to ascertain whether this is, in fact, the first maximum; but on the assumption that it is so, and that it corresponds to the maximum at $\alpha = 1{\cdot}8$ for spherical particles, it follows from (2) that the crystal grains are equivalent to spheres of about 2300 A. diameter.

Fig. 2 is a typical experimental graph of $\log_{10}R$ plotted against $\log_{10}\alpha = \log_{10}(2\pi r) - \log_{10}\lambda$ (with $2r = 2300$ A., so as to place the first maximum at $\alpha = 1{\cdot}8$). It is interesting to see that there is another turning point, though much less pronounced, at

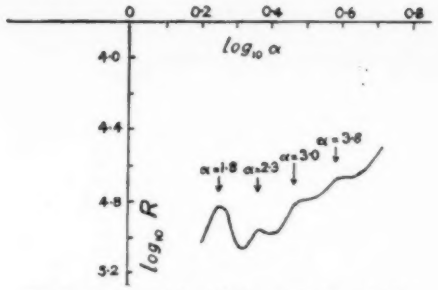

Fig. 2. Experimental scattering curve for rocksalt

$\alpha = 3{\cdot}8$, and also two more turning points in between at $\alpha = 2{\cdot}3$ and $\alpha = 3{\cdot}0$. These turning points appear at the same values of α in all our experiments, and they are therefore most likely to be due to the higher modes of vibration of the crystal scatterers.

In a cubic crystal the 'blocks' are probably also cubic in shape. The normal modes of vibration of a cube are easily calculated, as the wave numbers are proportional to the distances of the points of a cubic lattice from one of the lattice points. Accordingly, the ratios of the wave numbers are: 1, $\sqrt{2}$, $\sqrt{3}$, 2 . . ., and we should expect the values of α for the turning points of the scattering curve to have the same ratios. Starting from $\alpha = 1{\cdot}8$ for the fundamental vibration, one obtains the sequence $\alpha = 1{\cdot}8$, $2{\cdot}5$, $3{\cdot}1$, $3{\cdot}6$ . . ., which is indeed close to the observed sequence.

The preliminary results of our investigation thus show that data from the coherent scattering of visible and ultra-violet light provide quantitative information on the sub-microscopic, as distinct from the molecular, structure of real crystals. Our work is continuing with other crystals, a greater range of wave-lengths, and for different temperatures.

We have to thank the Council of the Royal Society for a government grant for the optical equipment, and the Department of Scientific and Industrial Research for a special research grant. [Dec. 2.

[1] Born, M., *Proc. Math. Phys. Soc. Egypt*, **3**, 35 (1947).
[2] Fürth, R., *Phil. Mag.*, **40**, 1227 (1949).
[3] Mie, G., *Ann. d. Phys.*, **25**, 377 (1908).
[4] U.S., Nat Bur. Standards, App. Math. Series, No. 4 (1949).

BIRDS AND RODENTS IN RELATION TO AGRICULTURE

A MEETING of the Association of Applied Biologists, held on March 16 at the Imperial College of Science and Technology, London, took the form of a discussion on the relation of birds and rodents to agriculture in Great Britain. Four papers and two films were presented, and provoked considerable discussion.

A. Roebuck, of the National Agricultural Advisory Service, summarized the work of his department on the wood mouse (*Apodemus sylvaticus*), most of which was done on farms in the east Midlands; the mice were not amenable to artificial conditions, and laboratory and small-plot experiments proved difficult. The wood mouse, which does not hibernate, is generally regarded as the most abundant mammal in Britain. Under natural conditions it breeds when five months old and lives for about eighteen months; breeding continues throughout most of the year, litters following each other at intervals of rather less than four weeks. The nests are about three feet underground, with three entrances; the burrows of other rodents and moles are sometimes shared.

The wood mouse has a very varied diet; grain and legume seeds, young shoots, young flower buds, crocus corms and tree bark are eaten. Animal food also seems necessary, and in captivity it is often a cannibal. It sometimes makes extensive stores of food, especially of field beans carried to old rabbit burrows, but often does not use them. Cereal crops, especially wheat, are sometimes badly damaged during the winter. Three types of damage have been recognized: nibbling off the young shoots as they appear above ground; uprooting the young plants and eating some of the seeds and tops, and scattering the rest; and eating out the hearts of young plants. In mature crops of wheat and linseed the mice sometimes climb the stems, and at times fell them, to obtain the seeds. Many of the feeding habits were observed in the laboratory.

The mice can readily be trapped alive, and marked individuals were recaught up to two hundred yards from the point of release. They have been trapped in abundance on the 'feeding front'—a straight line across the field—in wheat crops adjacent to woods. The maximum rate of advance of this 'feeding front' was found to be five yards a night. Attacks were stopped by prebaiting and poisoning on trays protected from other mammals and birds. Rabbits graze in the same manner, so that only trapping and field observations can determine which pest is responsible. Reviewing observations during 1934–51, Mr. Roebuck stated that large fluctuations in numbers occurred; grazing of winter cereals was noticeable only in periods of abundance. Other speakers stated that wood mouse damage has been confirmed in the north and south-west of England, and in north Wales. Oats are sometimes grazed, the hearts of cauliflowers eaten, and anemone beds attacked.

A film about farm rats was followed by a paper on rats and mice by Dr. D. Chitty, of the Bureau of Animal Population, Oxford. Most of the recent work on the biology and control of the brown rat and house mouse is still unpublished, and Dr. Chitty, in addition to his own observations, used information obtained by C. S. Elton, C. S. Middleton, H. N. Southern, Miss E. M. O. Laurie and other colleagues at Oxford. Damage by rats in fields is usually small, although greenstuff is probably a necessary part of their diet; fields are important reservoirs from which farm buildings and ricks are invaded in autumn. Damage to sacked goods is obvious and often spectacular; but losses from bins and troughs may not be fully appreciated. On one farm where hens had a continual supply of dry mash, rats were found to be eating more than the hens. Rats start entering ricks soon after harvest, and some ricks may have maximal infestations of about a hundred and fifty rats in January; considering all ricks, however, the average density of rats increases throughout the first three months of the year. Breeding is continuous, and it may be that the surplus of young accounts for the belief that rats leave the ricks in spring, for many remain, however late the threshing. In the Oxford district only six per cent of ricks had no house mice in them by April; almost half had fifty or more at that time. It is estimated that about fourteen hundred tons of wheat was eaten by rats and mice in the first three months of the year, for every hundred

thousand ricks standing on January 1; this does not allow for the grain spoiled but not eaten.

Dr. Chitty described in detail a technique of rat control by prebaiting and poisoning, which was developed after the behaviour of the rat had been studied, and which proved efficacious in nearly all environments. 25,000 acres could be almost cleared of rats by one man working full time at an annual cost of 2–3*d*. per acre (1946). Maintenance of a cleared area is tedious, however, and costly in comparison with the numbers of rats killed. Cats have proved admirable in preventing serious re-infestation, though unable to deal with well-established infestations. In the discussion that followed Dr. Chitty's paper, it was stated that the risk to other domestic animals of rat poison is small if the poison is handled intelligently. There is danger if poisoned corpses are left about to be eaten by dogs and cats. New poisons, less toxic to other animals, are being investigated, particularly in the United States. Rats can wander up to five hundred yards each night, although they sometimes remain within a range of a few yards. Dr. H. C. Gough reported rat damage to growing corn; channels are made along the drills and the seeds removed.

After a film about rabbits as farm pests, Harry V. Thompson, of the Ministry of Agriculture Infestation Control Division, read a paper on rabbits and referred briefly to the other rodents of the countryside. Damage to pasture is less obvious than that to arable crops; but recent studies by Miss W. M. Phillips in Cardiganshire, on the effects of rabbits on reseeded pastures and their value as lamb grazings, have shown that grazing by rabbits caused a marked reduction in the yield of total herbage, while there was an increase in the yield of weeds. The rate of growth of the herbage and the feeding value of the pasture in terms of lamb live-weight increment were also adversely affected. Rye grasses were eaten by rabbits in preference to clover and rape. A similar experiment is being carried out at Wye College, with the emphasis on the number of sheep displaced by a population of rabbits, rather than on herbage analysis. During the first seven months of the experiment (May–November 1950), the sheep live-weight increase on the rabbit-free plots was 800 lb., compared with 650 lb. on the rabbit-grazed plots.

Mr. Thompson said that damage to market garden and arable crops is well known. Entire fields of winter wheat or oats may be grazed down to the ground in a few days or weeks, and resowing is often necessary. Damage to spring cereals is more localized, but nevertheless may seriously reduce the crop. Members of the National Agricultural Advisory Service are aware of the importance of this damage[1]; further studies are being made in a number of provinces, and demonstrations of the damage for the benefit of farmers are being arranged. Rabbits prevent the natural regeneration of forests by eating seedlings, distort the growth of trees by damaging leading shoots, and kill trees by ring-barking. Orchards are particularly vulnerable, especially when pasture is scarce, and work on rabbit-repellent substances is at present in hand in Kent.

The use of poison baits is illegal, continued Mr. Thompson, and the killing of rabbits by viruses is not considered advisable in Great Britain. The established techniques of trapping, ferreting, gassing and snaring, with the use of dog and gun, and the long net, should all be employed, according to the terrain. Research is being done on the comparative efficiency of these methods of control in different environments. Long-term observations on the place of natural predators as a factor in rabbit control are necessary. The cost of rabbit clearance is higher in areas of abundant cover, long-standing infestation and entrenched trapping industry. In such areas mutual aid and constant vigilance on the part of owners and occupiers of the land, with resort to compulsory powers under the 1947 Agricultural Act when necessary, offer the only hope of control.

In the discussion that followed Mr. Thompson's paper, the president of the Association, R. W. Marsh, remarked on the great damage to fruit plantations in south-west England; he considered that one hare does as much damage as twenty rabbits in orchards. Dr. H. C. Gough spoke of the serious grazing of winter cereals; of 14,000 acres of winter corn in Hertfordshire last year, 25–30 per cent was a failure or severely damaged by rabbits. It is estimated that only 3–10 rabbits an acre are needed continually to graze and kill cereals. Little is known of the natural incidence of rabbit diseases, and there is no convincing evidence of population cycles in rabbits in Britain.

Dr. J. W. Evans, a vice-president of the Association, then put forward for discussion his view of birds in relation to agriculture. He gave short accounts of the reported harmful activities of the wood pigeon, rook, jackdaw, carrion crow, magpie, jay, blackbird and sparrow, and examined some of the claims that have been made that birds are of value in reducing the numbers of insect pests. An impression is widely held that, because most birds that damage crops also eat insects, the harm they cause to agriculture is to a large extent balanced by the benefits they confer. Statements are often made, for example, that rooks are a factor of significance in wireworm control, yet it is certain that the proportion of the wireworm population that they may eat in a field is so small as to be of negligible importance.

Dr. Evans suggested that birds ought to be protected because they are a part of our heritage, but not on the unproved grounds of their usefulness to agriculture or horticulture. In Great Britain enough food cannot be grown for the population, nor can we really afford to import all the food at present bought abroad. Because of this, any creature that on occasion causes substantial damage to the crops should be prevented from so doing—if possible, by driving them off; and if this is impossible then they should be destroyed, not by methods of wholesale slaughter, but by reducing their numbers in areas where damage is being caused.

Economic ornithology at present rests on so much assumption and approximation that it cannot claim to rank as an exact discipline of biological science. Although knowledge exists about the control of birds, some of it is of a slender nature. After giving particulars of control measures by the use of scarers, traps and narcotics, Dr. Evans made a plea that birds should be considered on the same basis as other organisms that threaten crops and not be placed in a special category for reasons based largely on sentiment. The only way in which the present position can be changed is by the establishment of a body of fact based on scientific investigation. Excellent work of this nature is being done at the Edward Grey Institute of Field Ornithology, Oxford, and Mr. P. H. T. Hartley was to have given an account of his investigation on titmice, but a sudden illness unfortunately prevented his attendance. However, a considerable amount of discussion followed Dr.

Evans's paper, and it was obvious that the plea to dispense with sentimentality when considering birds in relation to agriculture met with general approval.

Dr. F. Raw gave an example of the reduction of an outbreak of chafers by birds; but it was agreed that birds seldom effectively reduce an outbreak of insects or rodents. Dr. C. B. Williams thought it possible that certain birds might prevent the development of outbreaks. A. Roebuck and F. H. Jacob stated that the killing of hawks and owls, in addition to stoats and weasels, in game preserves, leads to great increases in rodent populations. It was emphasized that much work needs to be done on the qualitative and quantitative estimations of bird damage, on the influence of birds on insect populations, and on the mode of action and effectiveness of bird scarers.

The importance of rodent and bird pests to agriculture was made very clear at this meeting; but it was equally obvious that both the farming community and the man of science are very ignorant on many aspects of the problem. The work done during the past ten years, however, gives confidence that the problems are not being neglected, and it is hoped that the education of the farmer will keep pace with the discoveries of science. L. B.

[1] Gough, H. C., and Dunnett, F. W., *Agriculture*, **57**, 374 (1950).

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING OF THE SCOTTISH BRANCH

THE annual meeting of the Scottish Branch of the Science Masters' Association was held in the University of Glasgow during March 28–31. Prof. J. W. Cook, regius professor of chemistry in the University, was president of the meeting, which opened with a lecture by Prof. C. M. Yonge on "The Biological Exploration of the Sea". Prof. Yonge traced the development of this study from the earliest times to the present day, and outlined some of the work being done at the marine biological stations at Naples, Millport, Plymouth and Woods Hole, Massachusetts. The great oceanographic voyages of the *Beagle* and the *Challenger* were referred to, and time was also found for mention of the work of some research voyages recently completed.

The remainder of the morning was devoted to the annual business meeting of the Branch, and in the afternoon members and guests visited the Departments of Natural Philosophy and Chemistry of the University.

In the Natural Philosophy Department, the chief point of interest was undoubtedly the 300-million volt synchrotron and its associated controls, now nearing completion. Visitors were also shown experiments on resonance effects of nuclei, using the million-volt proton accelerator, and neutron experiments using the 50-kilovolt deuteron accelerator. Research work on the methods of detection of tracks of ionizing particles is going on in the Department, and methods demonstrated included photography of tracks in the Wilson cloud chamber, tracks in photographic emulsions, scintillation counters, electronic counting methods, and a powerful 18-ton electromagnet was seen in action with proportional counters. The teaching laboratories were also visited, and the demonstration of student experiments aroused great interest.

The Department of Chemistry staged a comprehensive demonstration of work in micro-analysis, X-ray crystallography, the reactions of tropolone (a seven-membered carbocyclic compound with aromatic properties), the determination of deuterium and the study of crystal growth. The latest desk-type of Philips Eindhoven electron microscope was another centre of interest throughout the afternoon.

In the evening there was a discussion on "Should modern ideas of the structure of the atom be taught in Scottish schools, and if so, to what extent and at what stage?" The discussion was opened by Prof. J. S. Rankin, of the Royal Technical College, Glasgow, and it was continued by others putting the views of chemistry teachers, physics teachers, training college lecturers and university lecturers. While there was general agreement that modern ideas of atomic structure should be taught, there was divergence of opinion as to the stage in the curriculum at which it should be introduced and the extent of the instruction.

The second day of the meeting (March 29) opened with a lecture by Prof. J. Monteath Robertson on "Chemistry and Crystallography". Recent applications of the 'new' crystallography to organic and inorganic chemistry were discussed. This was followed by a lecture by Mr. D. Hamilton-Schaschke, engineer-in-charge, Westerglen B.B.C. transmitting station, on "The Teaching of Sound". Pointing out that the reproduction of sound, good and bad, pleasant and unpleasant, impinges on our lives to a much greater degree nowadays than it did thirty years ago, Mr. Hamilton-Schaschke made a plea for the teaching of some of the basic principles in the secondary course in schools. The topics discussed included wave motion, harmonics, pitch, intensity, timbre, reverberation and acoustics of rooms. The lecture was illustrated by the use of a double-beam cathode ray oscilloscope, loud speakers of various designs and B.B.C. turntable equipment, with special records.

On the afternoon of March 29 members of the Association were the guests of the Lord Provost and magistrates at a civic reception in the City Chambers, and in the evening some of the latest science teaching films were shown. These included "L'Oeuvre Scientifique de Pasteur" (French), "Extraction of Magnesium from Sea-water" and "The Gift of Green—Photosynthesis" (American), and three short films on the teaching of electricity (British).

On March 30 the Royal Technical College opened its doors to the Association, and Mr. James E. Matthews, of the Electrical Engineering Department, gave a lecture on "Lightning". This lecture will long be remembered by all who were present as a model of perfect timing of speech, slide projection and demonstration with high-tension A.C. voltages. The apparatus used was constructed in the College workshops and the demonstration team handled it with precision. The spark-over demonstrations were spectacular and awe-inspiring, a fitting preliminary to the visit to the Loch Sloy Hydro-Electric Scheme which followed on March 31.

The last lecture of the meeting was given by Prof. Philip I. Dee, regius professor of natural philosophy. Prof. Dee gave a description of some of the research problems being investigated in his Department, with particular emphasis on the important general features of nuclear physics illustrated by them. He gave a description of the 300-million volt synchrotron shown to members on the first day, and outlined some of the experiments he and his staff hoped to do with it. He dealt at some length

with mesons and the way in which research workers hope to produce these particles artificially with the synchrotron.

Throughout the meeting exhibitions of scientific apparatus and scientific text-books were well attended by members and visitors, and one large laboratory was used for displaying apparatus invented, improved and constructed by science masters and their pupils.

Visits were arranged to a well-known shipbuilding yard, to chemical, optical and engineering works, to the Scottish Central Film Library and to Yoker Power Station. The final visit of the meeting took place on March 31 to the Loch Sloy Hydro-Electric Station on the banks of Loch Lomond. Here the members were shown over the generating room and the control room, but owing to a heavy fall of snow the visit to the dam some distance from the Station had to be cancelled.

ELECTRON MICROSCOPY IN GERMANY

THE electron microscope was invented in Germany, and its subsequent development into a standard research tool took place almost entirely in German laboratories until the outbreak of the Second World War in 1939. A considerable volume of work continued to be published until 1944. Throughout this period a very marked rivalry existed between three laboratories (those of Siemens–Halske, the AEG, and von Ardenne), which led to the duplication and even triplication of many investigations, and undoubtedly hindered the development of electron microscopy in wider fields. New techniques, rather than fruitful applications, were pursued, and the urgently necessary critical comparison with optical methods was neglected. Later work in the United States, Great Britain and France took a more balanced course, and has led to important contributions, especially in bacteriology and metal physics. Societies for furthering the new method were founded early in both Great Britain and the United States.

After the War most of the electron microscopes in Germany were removed by one or other of the victorious Allies (in roughly equal shares) and research teams were dispersed. However, with characteristic diligence, the production of improved models was quickly recommenced and the new models were put to use in many researches. A new spirit of co-operation also became apparent, and the first conference devoted solely to electron microscopy was held in 1949, as a result of which a Deutsche Gesellschaft für Elektronenmikroskopie was founded. Its formal inauguration took place at the second meeting, held at Bad Soden in April 1950, the proceedings of which are now recorded in a special number of the journal *Optik**.

The number and range of the contributions in this volume testify to the rapidity of the rebirth of the subject in Germany. Indeed, when the extent of the disorganization due to the War is taken into account, the volume and quality of the work reported are quite remarkable. Forty-two papers cover the theory and construction of the instrument, its specimen techniques and their application in physics, chemistry, technology and many branches of biology. Much of the work is in similar directions to that being pursued elsewhere, such as the comparison of the electron with optical and phase-contrast results, the reliability of replica methods, and the study of the detailed morphology of bacteria and viruses. Some investigations of special interest deserve mention. K. Beyersdorfer has studied the structure of graphite oxide, and E. Zehender that of evaporated films of zinc and cadmium. An extended investigation is reported by G. Pfefferkorn of the surface of calcite, both of natural cleavage faces and after etching, while A. Schrader compares the optical and electron-microscopical pictures of pearlitic structures in various steels. H. König is investigating the effect of the electron beam on specimens, particularly those of a biological nature. The fibrous structure of the vitreous humour of the eye has been studied by H. Ruska, and the fine structure of nerves by A. Jakob.

The report as a whole, running to some 150 pages, will provide the specialist in electron microscopy with much that is new, and at the same time show the general reader the wide scope which it now embraces.

V. E. Cosslett

* *Optik*, **7**, part 4–6 (1950): Report of Second Conference of the Deutsche Gesellschaft für Elektronenmikroskopie (Stuttgart). D.M. 7.

BUILDING RESEARCH BOARD

ANNUAL REPORT FOR 1949

TO those who have been fortunate enough to build since the War, whether house, office or factory, there is little to show that building research has continued. Plaster still cracks abominably, heating systems are too often poorly designed and inefficient, and plumbing seems as primitive and noisy as ever. However, the Director of Building Research makes it clear in his report for 1949* that these or related problems have received attention during the year, so that the shortcomings must be blamed on the unsuitability of materials readily available to-day, on poor craftsmanship or, perhaps, on the failure of the builder and manufacturer to reap the fruits of research.

The position seems to be different where monumental building is concerned. The Royal Festival Hall, on the South Bank site, London, has just been completed, and from what one has seen and from the account recently given by two of the engineers concerned, Messrs. E. O. Measer and D. H. New, in a paper read before the Institution of Civil Engineers, the results of researches in structures and materials were used and the staff of the Building Research Station were called upon directly to make surveys and to carry out investigations on the site so as to help in providing a successful solution to the difficult acoustic problem which naturally arose from placing a great concert hall in close proximity to Hungerford Bridge, which is a busy railway bridge crossing the Thames. It may be that the civil engineering contractor is more aware of the benefits to be derived from the adoption of scientific methods than the builder or, due to the higher proportion of university graduates employed by him, is in a better position to adopt them without loss of time. This state of affairs may have influenced the Building Research Board in its choice of problems, because it is clear from the 1949 report that a considerable proportion of the Building Research Station's effort is directed

* Department of Scientific and Industrial Research. Report of the Building Research Board with the Report of the Director of Building Research for the Year 1949. Pp. iv+60+16 plates. (London: H.M. Stationery Office, 1950.) 3s. net.

to civil engineering work rather than to what is popularly understood by building. Into this civil engineering category falls the work on highway bridges, on reinforced concrete structures and steel frameworks, and much of that on soil mechanics.

The investigation of the behaviour of composite steel – reinforced-concrete bridge deck slabs was continued during 1949, laboratory tests being carried out on a one-third scale slab, and full-scale tests were made, for the Ministry of Transport, to show the dynamic effect of a vehicle passing over a bridge. Some attention was also given to that interesting form of construction, the concrete shell roof, for which an entirely satisfactory method of design has yet to be developed. A test of a 60-ft. span shell barrel vault was made, and it is interesting to note that under a 50 per cent overload the deflexions were only of the same order as those observed due to temperature changes. Forty pre-stressed concrete floor-joists were tested for the Ministry of Works and investigation of the impact strength has been started; but there is no mention of more fundamental work on this material. It is satisfactory to see that once more the Station is giving some attention to the design of steel building-frames and that, using the same technique as was developed twenty years ago when the behaviour of a number of London buildings was investigated for the Steel Structures Research Committee, strain gauges have been fitted to the new Government buildings in Whitehall Gardens so that the stresses in the steelwork can be observed during each stage of building and during subsequent occupation. Laboratory tests designed to measure the effect of cladding, brick panel walls and reinforced concrete floors in relieving the steel framework are also reported as being carried out.

The activity of the Soil Mechanics Section during the year has been limited to three main lines: the study of the bearing capacity of soils in relation to foundations for large structures; excavations in difficult ground; and the stability of earth banks. On the theoretical side a general solution based on a theory of plasticity has been obtained for calculating an approximate value of the bearing capacity of foundations of all types, including footings and piles, in terms of the shear characteristics of the soil. Tables and graphs giving these bearing capacity factors have been completed for both clays and sands. A series of model tests has been carried out in the laboratory, using footings of various sizes and shapes located at different depths beneath the surface, and the results obtained so far have shown promising agreement with the theory. A study of the stability of the bottom of an excavation carried into water-bearing ground was being made, and results, summarized in a number of graphs, have already been obtained which should be of assistance to engineers in assessing the depth of penetration of sheeting necessary to ensure stability of the bottom of an excavation. Advice on the design, construction and maintenance of banks has been given to several river catchment boards, and work on electro-osmosis in soils has been continued.

In the building, as distinct from the civil engineering, field, interesting work has been carried out on the development of a satisfactory method of providing short bored pile foundations for houses on clay soils. Data of the safe bearing-capacity of such piles are now available, and the dimensions of suitable reinforced concrete beams, to span the pile heads and carry the house walls efficiently, have been determined.

A block of four houses, completed in March 1949, was being used for a study of heating by the circulation of warm air, and two blocks of flats, under construction in the ancient village of Abbots Langley, were to be used for a full-scale investigation into methods of sound insulation. The need for these will be fully appreciated by those who live in orthodox houses built since the War, with floor joists of reduced depth and plaster-board ceilings, which make it possible for the children in bed to converse with ease with their parents in the sitting-room below.

It is clear from this report that, though some builders and architects may still not make full use of it, the Building Research Station, which now has a branch laboratory in Scotland and close contacts with the British Colonies, is doing great work, particularly on the practical side, and is making it known. Almost five thousand inquiries, an increase of 859 over 1948, were received during the year, and ten thousand requests for sources of information or copies of publications were dealt with by the Station library.

FOREST PRODUCTS RESEARCH BOARD

ANNUAL REPORT FOR 1948

As an aftermath of the Second World War, work on research in many forest-products laboratories has had to be to some extent reorientated, as, for example, the great Madison Laboratory in the United States and the Research Institute at Dehra Dun and elsewhere. In the report for 1948 of the Forest Products Research Board and of the Forest Products Research Laboratory at Princes Risborough*, it is stated that during 1948 the highest priority was given in the programme of the Laboratory to those projects which bore upon the amelioration of the national timber situation, namely, to the accumulation of test and utilization data of new timbers, the search for substitute timbers and more efficient utilization. These investigations, mostly on timbers from Colonial sources, together with the very large volume of advisory and short-term work, now absorb most of the available time.

So far as the tropical and sub-tropical forests are concerned, it is very encouraging for the officers managing these forests to find that the possibilities have increased of being able to sell an increasing number of species of the mixed forest. Sylviculturally, it will render the work of obtaining the new crops to replace the old both more fascinating and, it may be hoped, easier. As in the past, one of the other staff usually called in when new timbers are coming up for consideration is the entomologist. Perhaps his investigations nowadays are more in connexion with the pinhole borers in hardwoods than in the old-time barkbeetle troubles with conifers.

The amount of advisory work in the Laboratory again exceeded the previous year by 10–15 per cent, and most of the time accruing from the recruitment of new staff has been taken up in dealing with it and with the tests on new Colonial timbers.

* Department of Scientific and Industrial Research. Report of the Forest Products Research Board, with the Report of the Director of Forest Products Research, for the Year 1948. Pp. v+46+12 plates. (London: H.M. Stationery Office, 1950.) 2s. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Composition and Function of Colostrum and 'Regression' Milk

We have been interested for some years in the similarities which exist between the composition of colostrum and 'regression' milk. By the latter term is meant the fluid which can be expressed from the mammary gland during its involution. Our attention was directed to these resemblances by a study of the cholinesterase in bitch's milk[1], and some estimations were accordingly made of the activities of other enzymes. It was not proposed to publish anything on the subject until further investigations had been made; but the appearance of Campbell, Porter and Petersen's communication in *Nature*[2] describing the accumulations of plasma cells in the bovine gland at the beginning of lactation and at the experimental close of milking, and their probable role in antibody production, has prompted us to place the results of our preliminary investigations on record at the present time in case they may be of value to others working on the subject.

	Protein (gm./100 ml.)		Acid phosphatase (King–Armstrong units per 100 ml.)			Alkaline phosphatase (King–Armstrong units per 100 ml.)		
	Full milk	Regression milk	Colostrum	Full milk	Regression milk	Colostrum	Full milk	Regression milk
Women								
A			35	3		64	3	
B			13	1		10	2	
C			18	2		21	2	
D			116	4		8	5	
E	1·5	2·4		4	19		2	10
F	0·9	1·9		3	9		5	12
G	1·3	9·4		6	176		4	47
Dogs								
A							4	24
						Cholinesterase (μl. CO_2/ml./min.)		
B						2,800	20	750

Representative findings have been summarized in the accompanying table. It is evident that the percentage of protein is higher in both colostrum and regression milk than it is in full milk. This fact was already well known about colostrum[3]. It is probably a composite result due partly to the presence of less water and partly to a smaller percentage of some of the proteins such as casein, coupled with a considerably greater percentage of others. At all events, the activities of the enzymes and probably, therefore, the concentrations of the specific enzyme proteins, are much greater in colostrum and regression milk than they are in full milk. The activity of the two phosphatases may rise to very different extents in the same regression milk, and in mother *G* the rise in the acid phosphatase far exceeded that in the alkaline. This excludes the changes being due merely to the removal of water. The mothers *E*, *F* and *G* were being treated with œstrogens, but since this treatment reduces the acid phosphatase in the serum, it can scarcely be the explanation for the greater rise of this enzyme in the regression milk. Specific changes in the secretion of the enzymes themselves must also be involved.

Any complete explanation of the secretions of the mammary gland must clearly take into account the composition of colostrum and regression milk. There may be a basic secretion from some cells in the ducts or alveoli to which is added, possibly from other cells, the water, casein, fat, lactose and salts characteristic of full milk.

It is usual to think of colostrum as a useful secretion produced in response to a positive humoral stimulus, but it is difficult to regard regression milk in quite the same way. It would be interesting to know which of the many constituents of colostrum have any functional value to the newborn animal, and if their re-absorption, or that of others, was of any benefit to the mother during the involution of the gland. Work now in progress here suggests that although puppies can be reared without being allowed to take colostrum, the high concentration of cholinesterase in it is of functional value to the developing animal. Nothing is known of its role during involution.

We would like to thank Dr. Mavis Gunther for advice and for supplying some of the human milks used in this investigation.

R. A. McCance
E. M. Widdowson
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Department of Experimental Medicine,
University of Cambridge. Dec. 21.

[1] McCance, R. A., Hutchinson, A. O., Dean, R. F. A., and Jones, P. E. H., *Biochem. J.*, **45**, 493 (1949).
[2] Campbell, B., Porter, R. M., and Petersen, W. E., *Nature*, **166**, 913 (1950).
[3] Widdows, S. T., Lowenfeld, M. F., Bond, M., Shiskin, C., and Taylor, E. I., *Biochem. J.*, **29**, 1145 (1935).

Changes in the Amounts of Adrenaline and *nor*Adrenaline in Rat Adrenals stimulated by Various Agents

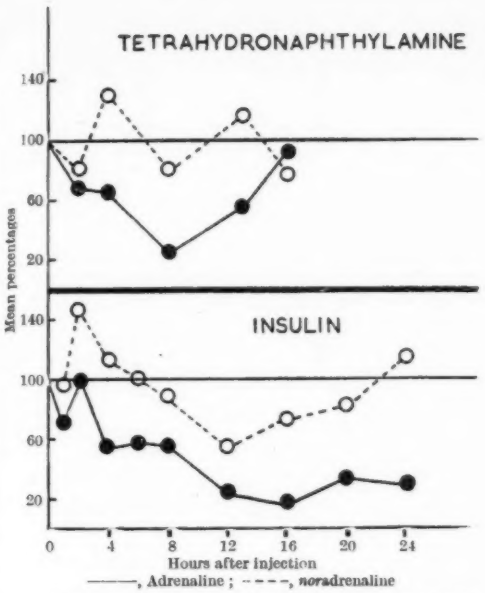
The amounts of medullary amines in the adrenals of an animal at any given moment is determined by a balance between synthesis and utilization.

Three drugs (insulin 1 unit, morphine hydrochloride 2 mgm., and tetrahydro-β-naphthylamine carbonate 7·5 mgm. per 100 gm. rat) known to cause a release of adrenal medullary hormone through the mediation of the splanchnic nerves were administered subcutaneously to groups of two to four rats. The rats were killed at varying times after injection simultaneously with equal numbers of uninjected rats serving as controls.

Extracts were made of the adrenals, and the amounts of adrenaline and *nor*adrenaline in each individual's glands estimated by the method of Crawford and Outschoorn[1]. This involves the prior separation of the amines by a paper chromatographic technique (phenol being used as the solvent) based on the method of James[2], their elution from the appropriate portions of the paper and an assay on the rat's blood-pressure. This preparation is fairly insensitive to traces of contaminating chemicals present in the eluates at the end of the chromatographic process and is therefore suitable for estimating small amounts of adrenaline and *nor*adrenaline obtained in this way.

The mean concentrations of the amines (in terms of body-weight of rat) in the injected groups were calculated as percentages of the mean concentrations in the control groups killed in each experiment simultaneously with the injected animals.

Adrenaline. The results obtained show that with prolonged activity of the glands utilization of adrenaline increasingly outpaces synthesis.



Mean amounts of adrenaline and *nor*adrenaline in rat adrenals stimulated by insulin and tetrahydronaphthylamine (as percentages of means of the controls)

Insulin depleted the medulla steadily, until after 16 hr. only 15 per cent of the adrenaline (compared with the control glands) remained. After this a tendency to recovery was noticeable. Tetrahydronaphthylamine produced a similar depletion—there being 25 per cent of the adrenaline left in 8 hr.—followed by recovery. With morphine, transient depletion of the glands (to 43 per cent of the original level) was achieved by four injections of the stated dose at hourly intervals. After only one injection there was no appreciable depletion of adrenaline during twenty hours observation.

Noradrenaline. The amounts of *nor*adrenaline did not follow the trend of the methylated amine. Neither morphine nor tetrahydronaphthylamine produced any lowering of the content of this amine below the range of the control animals, and the most powerful and longest acting (in the dosages employed) of the three agents, insulin, produced no more than a transient and statistically non-significant depletion of less than 50 per cent at 12 hr., recovery being complete in 16–20 hr. To get significant figures for this evanescent effect, a very large number of rats would have had to be killed.

These results suggest that under certain conditions of adrenal medullary activity there is either no output of *nor*adrenaline, or an output with which synthesis can keep pace, owing to the fact that the rat may be better able to synthesize the non-methylated amine than the methylated even when its medullary resources are heavily taxed.

Burn, Hutcheon and Parker[3] studied both adrenaline and *nor*adrenaline in rats' adrenals after insulin, using quite a different method. Finding that there was an increase of *nor*adrenaline after the glands had been active for several hours, they inclined to the view that when considerable utilization of adrenaline had occurred the animals succeeded in replacing it mainly with the non-methylated amine. Under the conditions of the present experiments, there was, as in the experiments of Burn *et al.*, a relative increase in the content of *nor*adrenaline; but evidence of an absolute increase was not obtained.

On the other hand, there was an indication that early in the course of the adrenal response (2–4 hr. after the injection of the drugs) the *nor*adrenaline content was increased 30–50 per cent above that of the controls. Although this increase was too small to be significant, it occurred following all three of the agents used.

Thus there does seem to be a tendency for the earliest response of the glands to be an increased production of *nor*adrenaline even while the demand for adrenaline can still be met. Non-significance of the results may be due to the fact that the response does not occur in every rat or does not occur at the same time in all rats.

The accompanying graphs show these features for insulin and tetrahydronaphthylamine.

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[1] Crawford, T. B. B., and Outschoorn, A. S., *Brit. J. Pharmacol.*, **6**, 8 (1951).
[2] James, W. O., *Nature*, **161**, 851 (1948).
[3] Burn, J. H., Hutcheon, D. E., and Parker, R. H. O., *Brit. J. Pharmacol.*, **5**, 417 (1950).

Seismic Refraction Experiments in the North Atlantic

The experiments of Hill and Swallow[1] in August 1949 showed that the method of seismic refraction shooting at sea, which had been developed at Cambridge, was suitable for deep ocean work. Effort was therefore applied to reap some of the harvest of results that await this new technique of studying the structure of the sea bed. Through the kind co-operation of the Hydrographer of the Navy, further experiments are being undertaken as part of the oceanographical work done by H.M.S. *Challenger* during her present survey cruise.

This communication indicates briefly the results obtained in the North Atlantic during the summer of 1950. The experimental method, using depth charges as sources of sound waves and sono-radio buoys as detectors, is similar to that used in the previous year. Lines up to 17 miles long were shot, giving 10–15 first-arrival observations. The results from the five stations occupied are summarized below. The probable error of individual determinations of velocities is less than 5 per cent.

(1) 47° 40′ N., 13° 40′ W. 2,540 fm. A single layer was observed, with a velocity for compressional sound waves of 19,100 ft./sec. This was covered by a layer or layers of undetermined sound velocity. Assuming that this overlying material is a partially consolidated sediment, in which the velocity is 6,000–8,000 ft./sec., its thickness would be 2,500–3,500 ft.

(2) 41° 46′ N., 35° 30′ W. 2,270 fm. A single layer in which the velocity of sound is 22,000 ft./sec. Again there was an unidentified upper layer, but its thickness would be only 800–1,200 ft., with the same assumption about velocities.

(3) 36° 08′ N., 62° 16′ W. 2,750 fm. Two layers, in which velocities of sound are 14,300 and 23,400 ft./sec. The first layer extended from near the surface of the sea-bed to a depth of about 12,000 ft.

(4) 32° 04′ N., 69° 39′ W. 2,920 fm. Three layers, in which the velocities are 6,050, 15,200 and 20,800 ft./sec. The first layer was approximately 1,500 ft. thick, the second 5,500 ft. thick.

(5) 27° 48′ N., 68° 28′ W. 2,880 fm. Three layers, in which the velocities are 6,800, 18,400 and 23,600 ft./sec. The thicknesses of the first two layers were 2,400 and 5,490 ft. approximately.

The probable thickness of sediment at station (1) is significantly less than the 9,200 ft. observed 400 miles to the north-west[1]. The velocity 19,100 ft./sec. in the lower layer indicates probably granite or palæozoic sedimentary rock. Station (2), on the western side of the Atlantic Ridge, shows very little sediment, and there was no indication of a 'granitic layer'. Stations (3), (4) and (5), in the Bermuda area, show a high-velocity layer at a depth of 7,000–12,000 ft. Again there is no indication of a 'granitic layer', except possibly the velocity of 18,400 ft./sec. at station (5), and in this case the thickness, 5,400 ft., is much less than on land. Alternatively, it is possible that all the layers overlying the 21,000–24,000 ft./sec. layer are sedimentary.

A short line in shallow water near Bermuda showed a uniform velocity of sound of 13,500 ft./sec. to a depth of at least 2,000 ft. This was probably limestone, and may perhaps be correlated with the 14,300 and 15,200 ft./sec. layers of stations (3) and (4). There is evidence for an increase of velocity with depth in the upper layer of sediment at stations (4) and (5), and allowing for this will increase the thickness of the upper layer, though probably by less than 1,500 ft. The effect of this on the total depth to the high-velocity layer would be only a few hundred feet. The thickness of the high-velocity layer was undetermined, but probably exceeds 15,000 ft.

The willing assistance of all concerned on board H.M.S. *Challenger* contributed largely to the success of these experiments and is gratefully acknowledged. The provision of equipment and explosives by the Ministry of Supply and the Admiralty is also acknowledged.

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Feb. 11.

[1] Hill, M. N., and Swallow, J. C., *Nature*, **165**, 193 (1950).

Paper Chromatography of Proteins

Franklin and Quastel[1] have recently applied the technique of paper chromatography to proteins. Protein–hæmin complexes were prepared, and the position of each protein on the chromatogram could thus be revealed by the benzidine reaction. The method has limited application since many proteins do not react with hæmin. Jones and Michael[2] have used acid dyes to stain proteins on the chromatogram.

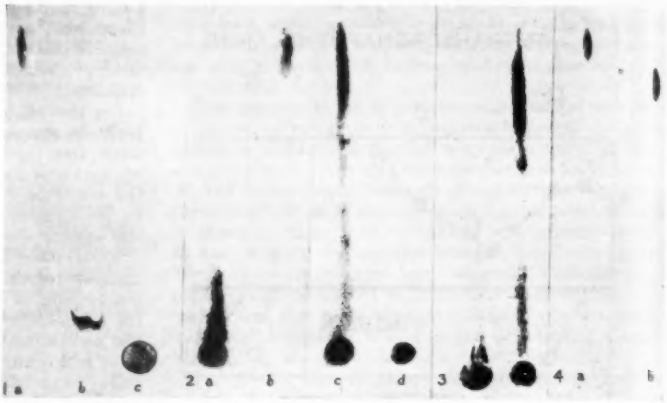

Fig. 1. Crystalline Insulin. (50 μgm.).
(*a*) Veronal sodium buffer *p*H 8·5 (Michaelis); (*b*) 0·1 *M* sucrose; (*c*) 0·5-saturated ammonium sulphate

Fig. 2. Fibrinogen, plasma proteins, albumin and γ-globulin in veronal buffer *p*H 6·5. (*a*) Human γ-globulin (kindly supplied by Prof. R. A. Kekwick). (50 μgm.); (*b*) human serum albumin, prepared by precipitation with 0·5-saturated ammonium sulphate, and dialysed against veronal buffer *p*H 6·5; (*c*) human plasma diluted five times with distilled water and 0·02 ml. taken for chromatography; (*d*) fibrinogen (Armour) (50 μgm.)

Fig. 3. Human plasma diluted five times with distilled water and 0·02 ml. taken for chromatography.
0·5-(left) and 0·1-(right) saturated ammonium sulphate respectively

Fig. 4. Crystalline egg albumin and crystalline bovine serum albumin (50 μgm.). Veronal buffer *p*H 6·5.
(*a*) Crystalline egg albumin (kindly supplied by Dr. H. M. Muir); (*b*) crystalline bovine serum albumin (Armour)

The present communication describes a simple technique based on the 'protein-error' of indicators which detects minute quantities of protein. 'Protein error' was first described by Sørensen[3] and is the phenomenon whereby protein interferes with the normal *p*H colour change of the adsorbed indicator. This principle has been applied by Feigl and Anger[4] in a spot test for proteins.

Our investigations have shown that, of many indicators examined, bromothymol blue proved most suitable in the following procedure, although tetrabromophenolphthalein ethyl ester also gave good results. One-dimensional ascending chromatography was carried out at 5° C. according to the procedure of Williams and Kirby[5]. As developing solutions, we used buffers and salt solutions, as suggested by Franklin and Quastel[1]. The filter strip was dried in air with the aid of an electric fan and then sprayed with the indicator (0·1 per cent aqueous solution of the sodium salt: Clark and Lubs[6]). The dye gave a blue-violet colour throughout, the area occupied by proteins being just discernible. After drying again in air, the strip was passed smoothly through 0·2 *N* acetic acid; this produced a pale yellow colour, except in the spot occupied by proteins which persisted violet-blue, or green with very small quantities. The chromatogram slowly turned blue on exposure to air, but could be preserved for several weeks between glass plates. If fading occurred, the original colour was recovered by passage through dilute acetic acid. If the buffer used for development of the chromatogram is in the acid range of the indicator (that is, below *p*H 4), a preliminary spray with 0·2 *N* sodium hydroxide is necessary. The subsequent procedure is as already described.

The method has been employed to detect many classes of protein subjected to paper chromato-

graphy (Figs. 1–4), 20 μgm. protein being detectable. Protein degradation products do not cause a 'protein error' with the above indicators and, therefore, are not recorded on the chromatogram. Since neither bromothymol blue nor tetrabromophenolphthalein ethyl ester contains nitrogen, we are exploring the possibility that quantitative analysis of protein mixtures may be achieved by nitrogen determinations of the spots.

We should like to thank Dr. T. H. H. Quibell of the Chemistry Department, University of Manchester, for kindly preparing a specimen of tetrabromophenolphthalein ethyl ester.

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[1] Franklin, A. E., and Quastel, J. H., *Science*, **110**, 447 (1949).
[2] Jones, J. I. M., and Michael, S. E., *Nature*, **165**, 685 (1950).
[3] Sorensen, S. P. L., *Biochem. Z.*, **21**, 131, 201 (1909).
[4] Feigl, F., and Anger, V., *Mikrochemica Acta*, **2**, 107 (1937).
[5] Williams, R. J., and Kirby, H., *Science*, **107**, 481 (1948).
[6] Clark, W. M., "The Determination of Hydrogen Ions" (Baillière, Tindall and Cox, London, 1928).

Homolytic Aromatic Substitution

The experimental facts and their theoretical interpretation for aromatic substitution by heterolytic mechanisms, including both electrophilic and nucleophilic reagents, are now well established. Although the possibility of homolytic aromatic substitution was recognized sixteen years ago[1], the absence of reliable quantitative data has hitherto made any comprehensive theoretical interpretation both difficult and speculative. Examples of homolytic aromatic substitution have in recent years been considerably extended and now include as substituting agents aryl radicals (from certain diazo compounds or acyl peroxides[2]), methyl radicals (from acetyl peroxide[3], lead tetra-acetate[4], phenyliodosoacetate[5] or the electrolysis of acetates[4]), halogen atoms (in non-catalytic high-temperature halogenation[6]) and hydroxyl radicals (from Fenton's reagent[7], the action of ionizing radiations on aqueous solutions[8], or the irradiation of aqueous solutions of ion pair complexes[9]).

In all substitution reactions involving free radicals on which quantitative data are available, the atom or group R in C_6H_5R is invariably *ortho-para* directing in type, as was, indeed, recognized by Grieve and Hey[1]; but the formation of the *meta* isomeride is not entirely suppressed except perhaps in the case of phenol. The hydroxylation of nitrobenzene by means of hydroxyl radicals appears to give 20–30 per cent of *m*-nitrophenol[7,9]. The action of aryl radicals ($C_6H_5^{\bullet}$, p-$CH_3.C_6H_4^{\bullet}$, p-$Br.C_6H_4^{\bullet}$), whether prepared from the diazo hydroxide, the nitrosoacylarylamine, the 1-aryl-3 : 3-dimethyltriazen, or the acyl peroxide, on nitrobenzene gives about 10 per cent of the 3-aryldiphenyl in each case[10]. In the hydroxylation of benzoic acid the formation of the three isomeric hydroxybenzoic acids in the approximate molar ratio $o : m : p :: 2 : 2 : 1$ has been reported[9]. From these results it appears that the differences displayed in the reactivities at the *ortho-*, *meta-* and *para-*positions to a substituent atom or group R are less accentuated in homolytic than in heterolytic substitution reactions. We classify all those atoms and groups as *ortho-para* directing which give rise to not more than 40 per cent substitution at the *meta* position.

The related problem of the influence of substituent atoms or groups on the velocity of homolytic substitution has been investigated by means of competitive reactions, and the results show that all such atoms or groups activate the nucleus[11,12]. In monosubstituted benzene derivatives the nitro-group shows the greatest activating influence, nitrobenzene being about three to four times as active as benzene. This observation is in agreement with the well-known effect of aromatic nitro-compounds in retarding and inhibiting polymerization[13]. Chlorobenzene has been found to react at a rate approximately 1·3 times that of benzene, while the rate of substitution in pyridine is very nearly equal to that in benzene. Here again the effect of substituent atoms or groups upon the reactivity of the nucleus as a whole towards attack by free radicals is less marked than in heterolytic substitution reactions.

Quantum mechanical interpretations of these results have been put forward by Wheland[14] and by Coulson[15], and close agreement with the experimental facts is obtained. So far as present knowledge goes, it is thus possible to recognize two criteria which serve to differentiate these reactions from the better-known reactions of aromatic substitution involving electrophilic or nucleophilic reagents. In homolytic aromatic substitution, *all* substituents both activate the nucleus and are *ortho-para* directing. The influences which control these phenomena, however, are free from Coulombic forces and are therefore less powerful than those which operate in heterolytic substitution reactions.

Further details of this work and the logical extensions thereof will be published elsewhere.

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[1] Grieve and Hey, *J. Chem. Soc.*, 1797, 1966 (1934).
[2] See Hey and Waters, *Chem. Rev.*, **21**, 169 (1937).
[3] Fieser and Oxford, *J. Amer. Chem. Soc.*, **64**, 2060 (1942).
[4] Fieser, Clapp and Daudt, *J. Amer. Chem. Soc.*, **64**, 2052 (1942).
[5] Sandin and McCormack, *J. Amer. Chem. Soc.*, **67**, 2051 (1945).
[6] Wibaut, *Experientia*, **5**, 337 (1949).
[7] Loebl, Stein and Weiss, *J. Chem. Soc.*, 2079 (1949).
[8] Loebl, Stein and Weiss, *J. Chem. Soc.*, 2704 (1950).
[9] Bates, Evans and Uri, *Nature*, **166**, 869 (1950).
[10] Hey and Nechvatal (unpublished work).
[11] Huisgen (private communication).
[12] Augood, Hey and Williams (unpublished work).
[13] Price and Durham, *J. Amer. Chem. Soc.*, **65**, 757 (1943). Price, *ibid.*, 2380.
[14] Wheland, *J. Amer. Chem. Soc.*, **64**, 900 (1942).
[15] Coulson, *J. Chim. Phys.*, **45**, 243 (1949).

Contaminant of Commercial 3: 4-Benzpyrene

In their studies of the metabolic products of 3 : 4-benzpyrene, Berenblum and Schoental[1] separated by chromatography a material ('fraction *V*') which had a fluorescence spectrum of much shorter wavelength than those of benzpyrene and its simple derivatives. The same spectrum was later given by a chromatographic fraction from the products of oxidation of 3 : 4-benzpyrene with osmium tetroxide[2]. It was then noted that the spectrum resembled that of 1′ : 2′ : 3′ : 4′-tetrahydro-3 : 4-benzpyrene[3].

This led to an examination of the commercial sample of benzpyrene used in both these investiga-

tions, and it was found that this sample was, in fact, contaminated with tetrahydrobenzpyrene which was separated from it by chromatography on alumina from light petroleum solutions. The most easily eluted fraction gave colourless leaflets (m.p. 110°, not depressed by an authentic sample, m.p. 113°) of 1′ : 2′ : 3′ : 4′-tetrahydro-3 : 4-benzpyrene[4].

The presence of this contaminant appears to have misled also at least one other worker[5], and we therefore record our finding.

We thank the British Empire Cancer Campaign for a grant which has supported this work.

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[1] Berenblum, I., and Schoental, R., *Cancer Res.*, **6**, 699 (1946).
[2] Cook, J. W., and Schoental, R., *J. Chem. Soc.*, 170 (1948).
[3] Schoental, R., and Scott, E. J. Y., *J. Chem. Soc.*, 1683 (1949).
[4] Fieser, L. F., and Fieser, M., *J. Amer. Chem. Soc.*, **57**, 782 (1935).
[5] 27th Annual Report British Empire Cancer Campaign, 229 (1949).

Peculiarity of Dichroism of Aromatic Molecular Compounds

The measurement of pleochroism in crystals of aromatic compounds has seldom been carried out, notwithstanding its importance from the theoretical as well as the experimental point of view. This was mainly due to the difficulties in obtaining crystal pieces suitable for the measurement. Tsuchida and Kobayashi[1] have devised an apparatus which consists in principle of a polarizing microscope and a sector photometer, and enables the measurement of dichroism with microcrystals obtained by ordinary procedures of preparation of substances. By this method the dichroism of metallic complexes[2,3] and aromatic compounds has been determined[4].

As one of the conclusions, it was found that the π-band is more bathochromic by *c.* 0·250 A., and several times more hyperchromic for light vibrating parallel to the benzene ring than for that perpendicular to the ring. This fact may be explained as the π-electrons in the benzene ring have higher density in the plane of benzene than in the direction perpendicular to the latter.

In recent studies of molecular compounds, *p*-$C_6H_4O_2$—*p*-$C_6H_4(OH)_2$, *p*-$C_6Cl_4O_2$—$C_6(CH_3)_6$, *s*-$C_6H_3(NO_2)_3$—*p*-$C_6H_4Br(NH_2)$, *s*-$C_6H_2Cl(NO_2)_3$—$C_6(CH_3)_6$ and *s*-$C_6H_3(NO_2)_3$—$C_{14}H_{10}$, the effect was found to be reversed; that is, the π-bands are more hypsochromic and hypochromic for the light vibrating parallel to the benzene ring than for that perpendicular to the plane of this ring. This fact may be explained as a change in electron density, suggesting the force contributing to the formation of these molecular compounds.

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[1] Tsuchida, R., and Kobayashi, M., *Bull. Chem. Soc. Japan*, **13**, 619 (1938); *J. Chem. Soc. Japan*, **60**, 769 (1939); "The Colours and the Structures of Metallic Compounds" (Osaka, 1944).
[2] Tsuchida, R., Yamada, S., and Yoneda, H., *J. Chem. Soc. Japan*, **69**, 145 (1948).
[3] Yamada, S., and Tsuchida, R., *J. Chem. Soc. Japan*, **70**, 44 (1949).
[4] Tsuchida, R., Kobayashi, M., and Nakamoto, K., *J. Chem. Soc. Japan*, **70**, 12 (1949).

A Suitable Hydrocarbon for Oil–Water Dispersion Measurements

The measurement of properties of emulsions and of interfacial phenomena is usually complicated by density differences between the 'oil' and aqueous phases and by the polarity of the oil. Sedimentation introduces non-uniformity and causes errors which cannot be assessed; creaming, by effectively increasing the concentration and bringing the drops into close contact, increases the rate of coagulation. Stirring or mixing is not usually permissible as it changes the size distribution. To overcome the former difficulty, workers have weighted their oils, often of 'Nujol' type, to the same density as that of the continuous phase. Thus, Sibree[1] added tribrommethane to medicinal liquid paraffin before measuring viscosities. This method is not to be recommended on account of (*a*) the appreciable solubility of tribrommethane in water, (*b*) its slow hydrolysis in aqueous solution, and (*c*) the introduction of a strongly polar compound. Similar arguments can be given against other weighting compounds, which are usually halogenated hydrocarbons.

To the requirements mentioned above can be added that of refractive index which, for easy and accurate microscopic measurements, should differ appreciably from that of the continuous phase. For weighted 'Nujol' and aqueous solutions at 25° C., $\Delta n \sim 0{\cdot}15$ gives reasonable definition. If the water be mixed with glycerin to study effects at high viscosities, and the 'Nujol' hence weighted still further, Δn decreases until at 76 per cent glycerin $\Delta n \sim 0{\cdot}06$, making accurate observation well-nigh impossible. Where water is one phase, the requirements for the oil are thus: density ~1, non-polar and $n_D > 1{\cdot}5$.

The physical properties of 3,3′ ditolyl tabulated below fulfil these conditions:

Temp. (° C.)	d_4^t	η (centipoise)	n_D (Abbe)	Δn
20·0	1·0013±0·0001	7·25±0·03	1·5962±0·00016	0·26
25·0	0·9989±0·0003	5·90±0·02	1·5930±0·00017	

This table was compiled from the measurements on eight preparations. In addition, the surface tension has been determined by the maximum bubble method at 20° C. to be $\gamma = 39{\cdot}0 \pm 0{\cdot}5$ dynes per cm. The parachor agrees well with that computed by the usual methods. The dipole moment is zero or very small. Although facilities were not available for an accurate determination, the dielectric constant at 25·0° C. was determined as $\varepsilon = 2{\cdot}51(9)$. 3,3′ Ditolyl can be cooled to ~1·5° C. without solidifying, and here $\varepsilon = 2{\cdot}52(3)$. This variation is within the experimental error of the apparatus. $n_D^2 = 2{\cdot}53(7)$.

The molar refraction for the *D*-line is unusual. The value of 62·0 c.c. corresponds to a molar exaltation of 2·1 c.c. over the value calculated from bond refractivities[2]. This is surprisingly higher than that quoted for diphenyl[3], namely, 1·8 c.c. The nearest strong absorption band in the ultra-violet is at 2500 A. (ε = *c.* 16,000)[4,5].

Dispersions of ditolyl in conductivity water, as anticipated, do not cream over long periods; in spite of the absence of an emulsifying agent, they are remarkably stable at concentrations of 1 per cent. Immediately after preparation, the droplet sizes range between 1 and 3 μ. At this concentration and diameter, the collision frequency due to Brownian

movement is small, and, where there is a density difference between the phases, sedimentation is the main rate-determining factor in the coagulation process[6] (for example, benzene in water).

3:3′ Ditolyl can be prepared by the method of Ullmann and Meyer[7], by heating *m*-iodotoluene with activated copper powder. The yield is poor, the product of doubtful quality and purification difficult. The method is inferior to that described by Mai and by Adams and Kornblum[8], involving the deamination of *o*-tolidinetetrazonium chloride with hypophosphorous acid, which gives yields of 70–80 per cent. This method (also described in "Organic Syntheses"[9]) is claimed to yield a pale yellow viscous oil of $n_D(20{\cdot}0) = 1{\cdot}5945$. The ditolyl, the properties of which are tabulated above, was colourless after repeated low-pressure distillation (*c.* 1 mm. mercury; b.p. *c.* 130° C.) and does not become coloured upon standing. Any yellow product which distils over during the first low-pressure distillation can be easily removed by passing a 5–10 per cent solution in benzene through a short alumina column, on which the coloured compound is strongly adsorbed as a bright red band. The ditolyl is easily eluted from the column, and subsequent low-pressure distillations yield a colourless, viscous oil, which distils unchanged. The ditolyl appears to supercool to − 16° C. before crystallizing into a white mass, but when solid melts at 5° C.[10].

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[1] Sibree, *Trans. Farad. Soc.*, **26**, 27 (1930); **27**, 160 (1931).
[2] Denbigh, *Trans. Farad. Soc.*, **36**, 136 (1940).
[3] Syrkin and Dyatkina, "Structure of Molecules", 203.
[4] Pickett, Walter and France, *J. Amer. Chem. Soc.*, **58**, 2296 (1936).
[5] O'Shaughnessy and Rodebush, *J. Amer. Chem. Soc.*, **62**, 2906 (1940).
[6] Lawrence, *Chem. and Indust.*, 615 (1948).
[7] Ullmann and Meyer, *Ann.*, **43**, 332 (1904).
[8] Mai, *Ber.*, **35**, 162 (1902). Adams and Kornblum, *J. Amer. Chem. Soc.*, **63**, 188 (1941).
[9] "Organic Syntheses", **21**, 32.
[10] Schultz, Rohde and Vicari, *Ann.*, **352**, 119 (1907).

Absorptiometric Determination of Tin by means of Dithiol

Clark's method[1,2] for determining very small amounts of tin makes use of the red-coloured suspension produced when dithiol (4-methyl-1,2-dimercaptobenzene) is warmed with an acid solution containing the tin. In its present form, the method has a serious disadvantage, in that it is necessary to compare visually the depth of colour (with that of standards) by means of reflected light. This technique imposes an unduly low limit on the precision obtainable, and full advantage of this promising method will not be gained until it can be adapted for photo-electric absorptiometry.

In his original investigation, Clark[2] attempted to measure the suspension by means of transmitted light, but concluded that more satisfactory results could be obtained with this system using reflected light. In order to stabilize the suspension, Clark incorporated some agar jelly, and this procedure has been followed by many subsequent workers. The addition of agar jelly itself tends to preclude the use of the absorptiometric technique owing to its own high and variable density. Gum arabic has been used by Stone[3]; but the use of reflected light was recommended in this case also. De Giacomi[4] used no dispersing agent; but again reflected light was deemed necessary.

We find that in the absence of any dispersing agent the suspension settles out too quickly to obtain accurate readings; but during a study of the effect of various modern dispersing agents it was found by one of us (C. K.) that 'Belloid T.D.', a sulphonated condensation product of naphthalene and formaldehyde marketed in solid form by the Geigy Co., Ltd., will not only stabilize the suspension for an hour or two, but also will render the system quite suitable for treatment by absorption spectrophotometry.

Several other dispersing agents have since been tried; but all except one were found to interfere with the reaction. The exception was 'Dispersol L', marketed in liquid form by Imperial Chemical Industries, Ltd., which has a composition similar to that of 'Belloid T.D.'.

The system can be stabilized up to a concentration of at least 10 μgm. per ml. An absorption maximum occurs in that region of the spectrum isolated by Ilford No. 605 filter.

It is proposed to submit a fuller account of this work for publication elsewhere. This note is published by kind permission of the Admiralty.

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[1] Clark, R. E. D., *Analyst*, **61**, 242 (1936).
[2] Clark, R. E. D., *Analyst*, **62**, 661 (1937).
[3] Stone, I., *Indust. Eng. Chem., Anal. Ed.*, **13**, 791 (1941).
[4] de Giacomi, R., *Analyst*, **65**, 216 (1940).

Exchange of Carbon-13 Dioxide between Solid Carbonates and Gaseous Carbon Dioxide

In a recent communication by Haul, Stein and Louw[1], results were given of experiments on the exchange between carbon dioxide and solid carbonates, using carbon-13 as a tracer.

Since the results of these experiments were calculated on a comparative basis, no corrections for background and oxygen-17 were made to the $^{13}C/^{12}C$-ratios. However, as in these experiments carbon dioxide from various sources was measured, it may be of interest to give the corrected values as well.

Thus, for carbon dioxide generated from 'Analar' barium carbonate (British Drug Houses, Ltd.) with perchloric acid, a value of 1·23 for the atomic per cent of carbon-13 was found, corresponding to a corrected figure of 1·13. A mixture of approximately equal amounts of this carbon dioxide with carbon dioxide from thermally decomposed dolomite gave a value of 1·24, which is corrected to 1·14. The mass spectrometer was at the same time checked with carbon dioxide generated from 'dry ice' (prepared from molasses by fermentation) and a corrected value of 1·09 per cent carbon-13 was obtained. These figures are in agreement with the findings of Murphy and Nier[2], namely, that the heavier isotope seems to be preferred in mineral carbonates.

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[1] Haul, R. A. W., Stein, L. H., and Louw, J. D., *Nature*, **167**, 241 (1951).
[2] Murphy, B. F., and Nier, A. O., *Phys. Rev.*, **59**, 771 (1941).

Identification and Crystal Habit of Chromium Carbide, $Cr_{23}C_6$, as determined by Electron Diffraction

During the course of an examination of 25/20 chromium nickel steels, residues obtained by electrolytic extraction were examined in a three-stage electron microscope. These residues had been previously examined by X-ray diffraction, which showed that the major phase was $Cr_{23}C_6$ together with some sigma phase. A feature of the electron microscope examination was the presence of structures which gave excellent single-crystal electron diffraction patterns. Fig. 1 shows a typical pattern which was obtained from the large transparent flake shown in Fig. 2. Fig. 3 shows another type of structure which gave a similar diffraction pattern. The type of structure present depends on the heat treatment of the steel; but all diffracting structures showed a marked hexagonal habit. The heat treatment was water-quenching from 1,100° C. followed by heating to 750° C. for a given time and then water-quenching. Heating for 4 hr. at 750° C. gave a specimen in which there were many transparent flakes (Fig. 2), whereas heating for 1,000 hr. at 750° C. gave specimens containing large masses made up of orientated triangles (Fig. 3).

The electron diffraction pattern (Fig. 1) shows a regular hexagonal cross-grating pattern with a spacing corresponding to 7·5 A. Furthermore, the roughly circular Laue zones enable the spacing of the lattice row which is nearly parallel to the beam direction to be determined as about 20 A. These measurements agree very well with those calculated from the known crystal structure of $Cr_{23}C_6$, namely, face-centred cubic (a_0 = 10·6 A.) orientated so that the {111} plane is approximately normal to the electron beam. The calculated spacings are 7·5 A. for the hexagonal pattern and 18·5 A. for the lattice row in the beam direction.

These results confirm the work of Mahla and Nielsen[1], who from a similar but more extensive series of electron micrographs concluded that the growth of chromium carbide in certain steels is controlled by the {111} lattice planes.

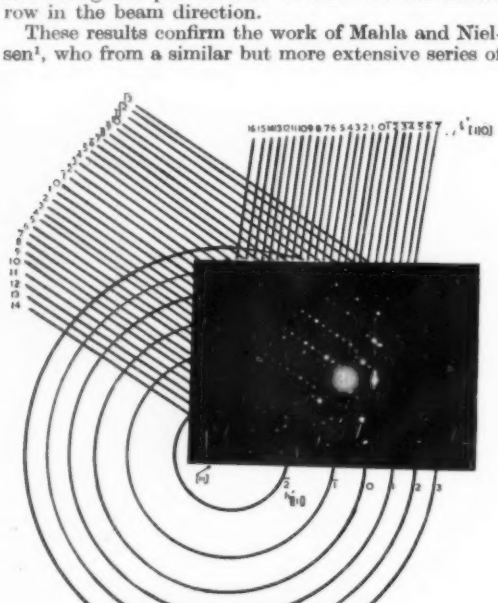

Fig. 1

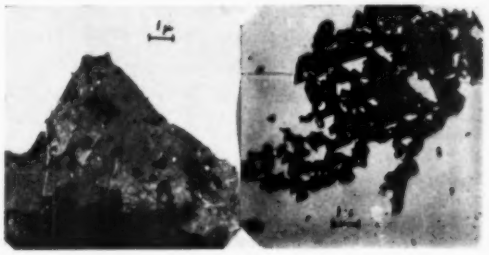

Fig. 2

Fig. 3

These results also illustrate how single-crystal electron diffraction patterns, taken from selected areas of the specimen in a three-stage electron microscope, may enable, in suitable cases, positive identification to be made of both the nature and crystal habit of phases.

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[1] Mahla and Nielsen, Amer. Soc. Met. Preprint No. 16 (1950).

Diverging Potentials and the Virial Theorem

I regret that, in a recent communication under the above title[1], I made somewhat misleading statements concerning the difficulties introduced in the Schrödinger theory by potentials which possess an r^{-n}-singularity ($n \geq 2$) at the origin. In particular, on the basis of the virial theorem, it was concluded that no bound state exists for a particle moving in an attractive potential of this kind.

Actually, an infinite number of such states exist in principle. It has been shown by Case[2], in a paper which appeared recently, that, furthermore, the eigenvalue problems in question are, in a certain sense, uniquely soluble. The difficulty which remains is that, in the non-relativistic Schrödinger theory, the energy-value spectrum extends from minus infinity.

The fact that the virial theorem leads to a different conclusion seems to mean that this theorem does not apply to the problems in question. I am indebted to Dr. A. S. Wightman for directing my attention to the above facts.

The apparent validity of the existing quantum - mechanical proofs of the virial theorem[3-6], under the single assumption of a bound state, misled me. It is clear that an additional condition

must exist, which has to be satisfied in order that the theorem may be immediately applicable. The proofs depend for their validity on it being mathematically justifiable to separate the integral representing the total energy into a sum of two separate integrals corresponding to the mean kinetic and potential energies, respectively. However, this operation can be justified when, and only when, the latter do not become infinite.

It is perhaps not unreasonable, therefore, to claim that the general idea of my first communication retains its validity to some extent, namely, that a simple application of the virial theorem suffices to demonstrate that the strongly singular potentials are unsatisfactory in the Schrödinger theory. One cannot conclude, as was done there, that the Schrödinger equation has no bound-state solution when $n \geq 2$. What one can conclude on the basis of the virial theorem is rather that *either* there exists no bound state, *or* the mean values mentioned above cannot all be finite. Either alternative is unsatisfactory from a physical point of view.

The second alternative can be seen to represent the actual situation by introducing the expressions for the wave-functions for S-states[2] into the potential-energy integral, which is then seen to diverge. Again (cf. ref. 2), the value of the angular momentum is unimportant for the general arguments.

In classical mechanics the situation is slightly different. For the motion of a particle in an attractive, spherically symmetrical potential, the virial theorem of classical mechanics is obviously valid, provided the particle does not move off to infinity or through the centre of force (origin). Thus, circular (periodic) motion with finite (constant) kinetic and potential energies will result, when the particle is given a velocity perpendicular to the position vector and when, at the same time, the magnitude of the velocity is such as to cause a cancellation of the attractive force by the centrifugal force. Hence, if the potential is proportional to r^{-n}, one can conclude (cf. ref. 1) that this circular motion will be energetically unstable when $n \geq 2$.

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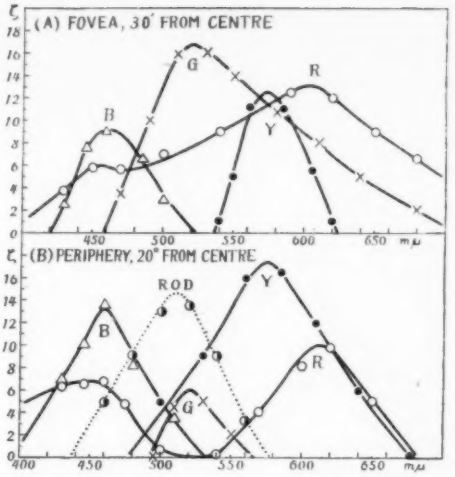
[1] Ore, A., *Nature*, **167**, 402 (1951).
[2] Case, K. M., *Phys. Rev.*, **80**, 797 (1950).
[3] Born, M., Heisenberg, W., and Jordan, P., *Z. Phys.*, **35**, 557 (1926). Born, M., and Jordan, P., "Elementare Quantenmechanik", 100 (Berlin: J. Springer, 1930).
[4] Finkelstein, B., *Z. Phys.*, **50**, 293 (1928).
[5] Fock, V., *Z. Phys.*, **63**, 855 (1930).
[6] Isenberg, I., *Phys. Rev.*, **79**, 737 and **80**, 917 (1950).

Retinal Colour Responses to Micro-stimulation

THE eye shows a supernormal sensitivity to an electric stimulus after exposure to light. This property was utilized by Motokawa[1,2] for analysing physiological processes of colour vision. In the present experiment similar measurements were carried out with a test-patch of reduced visual angle (2 minutes of arc), instead of a greater one of 2 degrees used in Motokawa's experiments. The apparatus for micro-stimulation was a reducing lens system similar to that devised by Hartridge[3].

Increases in electrical sensitivity over its resting level were measured at 1, 1·5, 2·25 and 3 sec. after



termination of a light stimulus of 2 sec. in duration, and values so obtained were denoted by R, Y, G and B respectively, which, for reasons stated in the previous papers, represent excitation of red, yellow, green and blue receptors respectively. If these values are plotted against the wave-lengths of pre-illuminating lights, the response curves reproduced (Fig. A) are obtained. The response curve R shows a maximum at about 610 mμ and another in the violet part of the spectrum. The maxima of the Y, G and B curves lie at about 575 mμ, 520 mμ and 460 mμ respectively. The fact that the curves R and G are higher than the curves Y and B in the fovea corresponds to the sensory fact reported by Hartridge[4] that the sensations of red and green or blue-green are predominant over those of yellow and blue when the size of test-objects is reduced. As a matter of fact, the intensity of our equal-energy spectrum was such that, at the reduced visual angle, only the middle range from about 640 mμ to 590 mμ was visible; the other parts of the spectrum evoked no light sensation. Nevertheless, the response curves for these sub-threshold lights could be determined by our method with the same degree of accuracy as for the over-threshold part of the spectrum. The data shown in Fig. (A) were obtained from a foveal region 30 minutes of arc from the centre.

As another series of experiments revealed, at the centre of the fovea there was no measurable Y, and the value of B was also very small there. On the other hand, high values of R and G were found, and these findings indicate that the centre of the fovea is really dichromatic, as was suggested by König[4] and by Willmer and Wright[6]. As the measuring area moved from the centre towards the periphery, the values of Y and B increased steadily, but were found decidedly lower within the fovea than in the parafovea, whereas the values of R and G were found to be much higher in the fovea than in the parafovea. Hartridge advanced a hypothesis that the notch in the luminosity curve found by Wright[7] is due to the dropping out of action of a specific yellow ... ceptor with a reduction of visual angle, and his hypothesis receives strong support from our experiment.

For comparison, response curves taken at 20° from the centre under experimental conditions otherwise

the same as above are shown in Fig. *B*. As can be seen, prominent development of the component *Y* and marked reduction of the component *G* are the main differences from the results for the fovea. In connexion with this finding, it should be noted that the same features are also typical characteristics of the results obtained from the foveæ of green-blind subjects. For a certain reason the component *Y* escaped Motokawa's notice in his previous study of colour-blindness[3], but our further work on a considerable number of subjects has provided irrefutable evidence that *Y* is the most conspicuous component existing in the foveæ of anomalous trichromats and dichromats. Various difficulties encountered by the three-colour theory of Young, such as the similarity of the luminosity curve of a deuteranope to that of normal man, preservation of sensitivity to yellow of dichromats, etc., may easily be accounted for in terms of the component *Y*.

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[1] Motokawa, K., *J. Neurophysiol.*, **12**, 291 (1949).
[2] Motokawa, K., *J. Neurophysiol.*, **12**, 465 (1949).
[3] Hartridge, H., *Phil. Trans.*, B, **232**, 519 (1947).
[4] Hartridge, H., "Recent Advances in the Physiology of Vision" (London, 1950).
[5] König, A., *S.B. Akad. Wissensch.*, 559 (Berlin, 1897).
[6] Willmer, E. N., and Wright, W. D., *Nature*, **156**, 119 (1945).
[7] Wright, W. D., *Nature*, **151**, 726 (1943).

Viability of *Ascaris lumbricoides* Eggs 'Preserved' in Formalin

In March 1950, a fæcal specimen was collected from a patient in the Brisbane General Hospital, who was infected with *Ascaris lumbricoides*. This was preserved by the addition of hot 10 per cent formalin. The material was used afterwards in May and August to teach the Willis salt flotation method for demonstrating helminth infection. Nothing unusual was noted.

On November 15, 1950, this same preserved fæcal specimen was used in a practical examination in parasitology. During the examination, attention was directed by one of the students to the fact that developed larvæ were actively moving within many of the *Ascaris* eggs. The temperature was 77° F. Later examination of the specimen, on a cooler day (temperature 70° F.), showed the larvæ within the eggs to be inactive; but when the slide was warmed slightly they became quite active.

Analysis in November by Mr. J. P. Callaghan, in this laboratory, showed that the concentration of formalin in the specimen was not less than 6 per cent (2·4 per cent formaldehyde).

Another fæcal specimen was preserved by the same method, but relatively less fæces were mixed with an equivalent amount of formalin. When the analysis was carried out (in November) this proved to have a concentration of 18·5 per cent formalin (7·4 per cent formaldehyde). This specimen had been kept in a jar with a screw top which would permit evaporation of the water and probably polymerization of the aldehyde. The *Ascaris* eggs in this specimen had not developed at all.

The temperature-range from March 29 to November 15, 1950, was between 42·8° F. min. and 92·7° F. max.

This observation stimulates thought as to the limits of formalin concentrations in which nematode eggs can be preserved. The lower limit may indicate the point below which bacterial growth is inhibited and the development of the nematode egg stimulated, the upper limit being the concentration of formalin necessary for killing, fixing and preserving the eggs.

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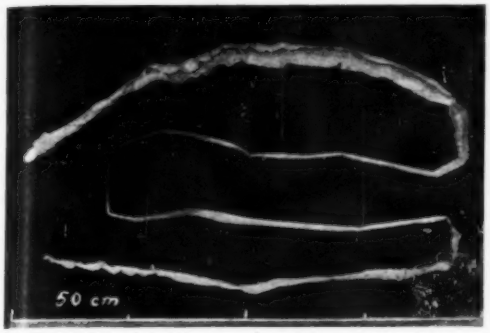
Balanoglossus gigas Fr. Müller rediscovered on the Brazilian Coast

The largest known species of Enteropneusta was discovered by Fritz Müller on the Brazilian coast, at a place named Armação da Piedade, in the State of Santa Catarina. Fritz Müller's notes in which he describes the animal were fortunately collected and published in the year 1898[1] by Dr. Hermann von Ihering, former director of the Museu Paulista of São Paulo. In those notes (p. 36), Fr. Müller said that he caught many tornaria larvæ from 1860 onwards in the plankton off the same beach. The first *Balanoglossus* was captured in 1884, and in the following year many others were caught. The extraordinary size of the animals (1·5 m. in length) justified the name *Balanoglossus gigas*. Some of the specimens were sent to Spengel[2], who gave them in 1893 a new description and re-named them *Ptychodera gigas*. In a later monograph on the Hemichordata, recently published, van der Horst[3] re-described the same animal under the name of *Balanoglossus gigas* Fr. Müller.

Since 1885 no other *Balanoglossus gigas* has been captured on the Brazilian coast. In 1948 some signs of the existence of Enteropneusta were detected by Prof. W. Besnard, on the shore of São Sebastião, on the northern littoral of the State of São Paulo. At that time a few fragments of the animal were collected and kindly sent to the Department of General and Animal Physiology for study. Since then, several trips have been made to obtain this Enteropneusta, but only broken portions of the animal were dug out from the deep galleries they burrow in the beach.

Last September, during a short visit to São Sebastião, a new attempt was made to get a complete animal. At the lowest tide numbers of the coiled 'castings' may be seen on the beach. To catch the animal it is necessary to make a large hole of 1·0–1·5 m. in diameter and 0·3–0·5 m. in depth. The animal forms a kind of tubular gallery by means of the abundant mucus secreted by the skin. When these tubular galleries are opened, there is a strong odour like iodoform and the animal may be seen moving slowly in the gallery with the posterior end kept upright. To get a complete specimen, it is necessary to open the gallery carefully, following the different parts of the body, to reach the proboscis. In this way one complete *Balanoglossus* was captured. The living animal was 1·8 m. in length. Large fragments of several other specimens of about the same size were also taken.



Balanoglossus gigas. Complete specimen; immature female

From the descriptions by Spengel and van der Horst, the animal has been identified as *Balanoglossus gigas* Fr. Müller, now found again on the Brazilian coast sixty-six years after its discovery.

This specimen has been fixed in formalin after anæsthetization (7·5 per cent magnesium chloride plus sea water). Under these conditions the animal presents the following dimensions: total length, 1·55 m.; proboscis, length, 13 mm., breadth, 10 mm.; collar, length, 16 mm., breadth, 14 mm.; branchial region, 8·2 cm.; genital region, 28 cm.; lever region, 5·0 cm.; abdominal region, 105·0 cm.; genital wings, 3·7 cm. broad.

The proboscis and the collar of the living animal are yellowish-white; the branchial and the genital regions are violet; the hepatic region shades to green-yellow, and the caudal region is whitish and semi-transparent. Histological examination of the genital wings indicated that this specimen is an immature female. The eggs are 105–115 μ in diameter.

Large fragments of other specimens have also been examined. From them several living eggs were observed under the microscope and most of them were provided with a fertilization membrane. Fragments of mature males and females show that the genital wings are respectively orange-yellow and yellowish-white in colour.

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[1] Müller, Fr., Observações sobre a fauna marinha, *Rev. Mus. Paulista*, 3, 35 (1898).
[2] Spengel, J. W., "Die Enteropneusten des Golfes von Neapel.", 159 (1893).
[3] van der Horst, C. J., *Bronns Tierreichs*, 4, No. 4, 717 (1939).

Elemental Composition of Sugar-cane Leaf and Stem in relation to Nitrogen Deficiency

NITROGEN deficiency has been known to bring about certain specific changes in growth, physiology and composition of sugar-cane plants[1,2]. Its effect on mineral composition is less clearly understood. To throw light on this problem, sugar-cane variety Co 453 was grown in (1) Hoagland's complete nutrient culture, and (2) Hoagland's nitrogen-deficient culture for the entire life-cycle[3]. Percentages of nitrogen, P_2O_5, K_2O, calcium, magnesium and sulphur in sugar-cane leaf and stem were estimated at maturity according to standard methods of analysis and expressed as percentages of dry weight.

Nitrogen deficiency lowered total nitrogen content of both stem and leaf. Other constituents in the leaf were, on the contrary, increased in deficient cultures. P_2O_5 and magnesium contents were increased more in the stem than in the leaf, while K_2O was higher in leaf but did not change appreciably in stem. Calcium, on the contrary, showed a marked decline in the stem under nitrogen deficiency while its concentration in the leaf did not vary significantly from the control. Sulphur content also varied only slightly with nitrogen deficiency in both stem and leaf (see accompanying table).

	Leaf			Stem		
	Complete nutrition	Nitrogen deficiency	Difference % control	Complete nutrition	Nitrogen deficiency	Difference % control
	A. Percentage of elements in dry matter					
N	1·982	1·204	−39·25	1·875	1·140	−39·2
P_2O_5	0·255	0·401	57·25	0·046	0·105	128·26
K_2O	1·175	1·305	11·06	0·402	0·408	1·49
Ca	0·188	0·190	1·59	0·052	0·021	−59·61
Mg	0·193	0·230	19·17	0·047	0·083	76·59
S	0·221	0·222	0·45	0·064	0·068	6·25
	B. Percentage of elements in N–P–K unit					
N	58·60	41·37	−29·41	80·71	68·96	−14·58
P_2O_5	7·54	13·78	84·08	1·98	6·35	220·71
K_2O	34·74	44·84	29·07	17·30	24·68	42·66

In leaf, nitrogen starvation lowered N/P_2O_5, N/K_2O, N/Ca, N/Mg, N/S, K_2O/P_2O_5, Ca/P_2O_5, Mg/P_2O_5 and S/P_2O_5 ratios characteristically. Absence of this ingredient, therefore, caused a greater increase in all the major elements in comparison to nitrogen; a higher P_2O_5 content in comparison to other major elements was also recorded.

In stem, deficiency resulted in marked reduction in N/P_2O_5, K_2O/P_2O_5, Ca/P_2O_5, Mg/P_2O_5 and S/P_2O_5, indicating thereby that the proportion of phosphate absorbed was greater than all other macro-elements taken up by the plant. Significant reductions in K_2O/Mg, K_2O/S and Ca/K_2O and N/K_2O indicated that the quantity of magnesium and sulphur was relatively higher in comparison to K_2O, while the quantity of nitrogen and calcium was lower than that of K_2O. Further, reduction in N/Mg, N/S and Ca/N ratios indicated the relatively higher quantity of magnesium and sulphur in comparison to nitrogen and relatively lower quantity of calcium in comparison to nitrogen in deficient canes.

The quantity of nitrogen, P_2O_5, and K_2O in both leaf and stem expressed as milligram equivalents and calculated as percentage of these ingredients in the composite N–P–K unit[4] showed that nitrogen deficiency markedly reduced the proportion of this ingredient in the total N–P–K unit to the extent of 29 per cent in leaf and 14 per cent in the stem. K_2O was higher in deficient cultures by 29 per cent in leaf and 42 per cent in stem. P_2O_5 was also increased by 84 per cent in leaf and 220 per cent in stem. Deficiency symptoms of nitrogen thus appeared to be interrelated with sufficiency effects of phosphorus and potassium in leaf and stem of sugar-cane.

Under reduced supply of nitrogen, therefore, marked variations in other mineral constituents take place. The effects of nitrogen deficiency on various physiological processes must therefore be analysed in terms of the concentration and ratio in which

different nutrients are present at centres of high metabolic activity. The significance of these effects will be discussed in a separate communication.

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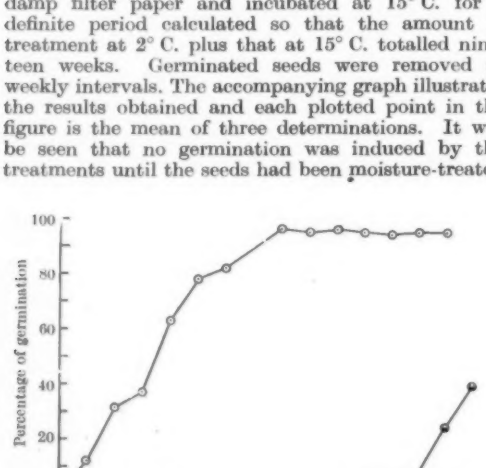
[1] Clements, H. F., *et al.*, *Hawaiian Planter's Rec.*, **25**, 227 (1941).
[2] Singh, B. N., *et al.*, Progress Report of Researches on Physiology of Wheat and Sugar-cane, I.C.A.R., India (1940–42).
[3] Lal, K. N., and Mehrotra, O. N. (unpublished data).
[4] Thomas, W., *Plant Physiol.*, **12**, 571 (1937).

Germination of Seeds of *Bartsia odontites*

In the first stages of an investigation into the growth requirements of certain members of the British Rhinantheæ, it was found that the seeds of *Rhinanthus crista-galli* and *Bartsia odontites* do not germinate when exposed to moisture at 15° C. or 20° C. for periods of up to one year. It was hence considered necessary to establish conditions which would permit germination to be brought about as required in the laboratory. The work of Heinricher[1] showed that in pot culture the seeds of *Bartsia* and *Rhinanthus* spp. would germinate in the absence of the roots of suitable host plants, but that the majority of the seeds would not germinate for some months after being exposed to moisture. Heinricher also suggested that the germination of these seeds might be influenced by the degree and duration of the winter coldness. Accordingly experiments were set up which were designed to study the effect of low-temperature stratification on the germination of the seeds of *Bartsia odontites* and *Rhinanthus crista-galli*. The present communication concerns the effect of this treatment on *Bartsia* seed germination.

In the investigation three lots of freshly gathered *Bartsia* seed were exposed to moisture at 2° C. At weekly intervals samples of each lot were placed on damp filter paper and incubated at 15° C. for a definite period calculated so that the amount of treatment at 2° C. plus that at 15° C. totalled nineteen weeks. Germinated seeds were removed at weekly intervals. The accompanying graph illustrates the results obtained and each plotted point in the figure is the mean of three determinations. It will be seen that no germination was induced by the treatments until the seeds had been moisture-treated at 2° C. for five weeks. After twelve weeks of treatment at 2° C. followed by six weeks of exposure to moisture at 15° C., 95 per cent of the seeds had germinated. From the twelve-week period onwards, the effect of the additional 2° C. treatment was to shorten the length of the subsequent treatment at 15° C. required to give maximum germination. Thus, after eighteen weeks, maximum germination was induced by exposure to moisture at 15° C. for one week. It will also be seen that after sixteen weeks a progressively increasing number of the seeds had germinated at 2° C.



○—○—, Germination at 15° C.; ●—●—, germination at 2° C.

I wish to acknowledge the assistance of Dr. E. M. Burrows, who collected the requisite *Bartsia* seed.

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[1] Heinricher, E., *Jahrb. wiss. Bot.*, **36**, 665 (1901); **46**, 273 (1909).

Motility Testing of *Bact. coli* O Group III Strains

Hilton and Taylor[1] obtained highly motile cultures of *Bact. coli D* 433 and of four other *Bact. coli O* group 111 strains by repeated subculture in nutrient broth and semi-solid agar and incubation at 22° C.; the period of passage required for this change was three to four weeks in semi-solid agar and slightly longer in broth. In this Laboratory, *Bact. coli D* 433 and other *Bact. coli O* group 111 strains have been found to develop a high degree of motility in 18–24 hr. under the following conditions. The strains are inoculated by a straight wire into 3 ml. of semi-solid agar (5 parts digest ox-heart broth + 1 part nutrient digest ox-heart agar, final *p*H 7·4–7·6) in small screw-capped bottles (bijou type). A microscopic examination for motility is made of the surface growth which develops in 18–24 hr. at 20–22° C. The method has been used satisfactorily for routine motility testing of these organisms when subcultured direct from stock strains (stored at room temperature for 6–22 months in nutrient digest ox-heart agar stabs or on slopes of Loeffler's serum medium) or from fresh subcultures on MacConkey's medium.

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[1] Hilton, R. E., and Taylor, J., *Nature*, **167**, 359 (1951).

Occurrence of *Asparagopsis armata* Harv. on the Scilly Isles

The red alga, *Asparagopsis armata* Harv., was originally found in Australia, where it is very abundant along the south coast; it occurs also in New Zealand and Tasmania[1]. It was first recorded in the northern hemisphere in 1925 by Sauvageau[2]. Its naturalization along the European and North African coasts has been followed and described by J. Feldmann and G. Feldmann[3] and shown to be coincident with that of *Falkenbergia rufolanosa* Harv., the tetrasporic generation of *A. armata*. No occurrences were recorded north of the coast of Brittany. Since that account, however, *Asparagopsis* has been found at

two stations on the coast of Co. Galway, west Ireland, by de Valera[4] in July and October 1941; it has also been found in Cornwall by Drew[5] on the Lizard Peninsula, where it was well established in August 1950, and she has found specimens of *Falkenbergia* cast ashore on the Lizard and at Falmouth, in August 1950. It is not without interest, therefore, to note the presence of *Asparagopsis armata* on the Scilly Isles. Several plants were found growing tangled among *Chondrus crispus* (L.) Stackh. and *Laurencia pinnatifida* (Gmel.) Lamour, on a boulder which projected from the sandy shore at the south end of Pentle Bay, Tresco, at extreme low water, spring tide, on March 24, 1951. The specimens have the characteristic reflexed barbs on otherwise bare branches; the fronds are up to four inches long, and these specimens show neither cystocarps nor spermatangial branches. I am grateful to Dr. Mary W. Parke for her kindness in identifying the specimens and for the loan of literature.

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[1] Harvey, W. H., "Phycologica Australica" (London, 1858–63).
[2] Sauvageau, C., *C.R. Acad. Sci., Paris*, **180** (1925).
[3] Feldmann, J., and Feldmann, G., *Ann. Sci. Nat. Bot.*, **11**, 3, 75 (1942).
[4] de Valera, M., *Irish Nat. J.*, **8**, 30 (1942).
[5] Drew, K. M., *Nature*, **166**, 873 (1950).

Production of 'Whiptail' in Cauliflower Grown in Sand Culture

The importance of molybdenum deficiency in the incidence of 'whiptail' in cauliflower and broccoli in acid soils is now established[1–4]. The disorder was known only under field conditions until recently, when cauliflower plants grown in molybdenum-deficient sand cultures[5] showed symptoms closely resembling certain aspects of the disease. In later work[6,7], analogous effects (death of the growing point and malformation of young leaves) developed in several *Brassica* species; but their occurrence was sporadic and unpredictable, except that they appeared after temporary recovery from an initially severe deficiency. Two features characteristic of many cases of 'whiptail', namely, plants with dark blue-green, narrow, elongated middle foliage and large well-developed outer leaves free from chlorosis, were generally lacking in the work cited.

'Whiptail' plants in all respects typical of those seen in the field[3,4] have now been produced consistently at will in sand cultures. The main conditions are an abundant supply of nitrogen (350 p.p.m. nitrogen (25 m.eq./l.nitrate)), and a carefully controlled low level of molybdenum (0·00005 p.p.m.), given regularly in the solution from sowing. In these circumstances growth is initially vigorous and foliage is dark green. Old leaves are large; but young leaves later break down and fail to develop laterally. They often continue rapid elongation (recorded only once previously[5]), even when practically devoid of lamina, and attain their normal length, thus producing the characteristic appearance from which the name has its origin (see photograph). Death of the growing point may occur suddenly. In other plants severe deficiency (less than 0·000005 p.p.m. molybdenum) with lower nitrogen-levels inhibited the appearance of the 'whiptail' symptoms, which readily developed after increasing the supply of nitrogen and

molybdenum to the levels stated. The molybdenum level is apparently adequate for considerable (but still restricted) nitrate assimilation, but remains insufficient to satisfy some other role in leaf development in certain Brassicæ.

E. J. Hewitt
S. C. Agarwala

Long Ashton Research Station,
Bristol.
Dec. 18.

[1] Waring, E. J., Shirlow, N. S., and Wilson, R. D., *J. Aust. Inst. Agric. Sci.*, **13**, 187 (1947).
[2] Waring, E. J., Wilson, R. D., and Shirlow, N. S., *Agric. Gaz. N.S. Wales* (Dec. 1948–Jan. 1949). Mis. Pub. No. 3, 354 (1949).
[3] Plant, W., *Nature*, **165**, 533 (1950).
[4] Plant, W., *Agriculture*, **57**, 130 (1950).
[5] Hewitt, E. J., and Jones, E. W., *J. Pomol. and Hort. Sci.*, **23**, 254 (1947).
[6] Hewitt, E. J., and Jones, E. W., Ann. Rep. Long Ashton Res. Sta., 81 (1948).
[7] Hewitt, E. J., and Jones, E. W., Ann. Rep. Long Ashton Res. Sta., 58 (1949).

Relation of the Essential Oils of *Coronopus didymus* to the Tainting of Butter

Coronopus didymus is a cruciferous weed which grows abundantly in the summer rainfall areas of northern New South Wales and southern Queensland. When eaten by cows, a characteristic taint is produced in the milk, cream and butter, resembling, particularly in butter, a scorched or burnt flavour. This taint is intensified by heat treatment of the cream and is responsible for considerable economic loss. The taint cannot be controlled by removal of the cows from the affected areas a few hours before milking, or by modern methods of cream processing in the factory.

Benzyl cyanide and two high-boiling hydrocarbons were found to constitute the greater part of the essential oil of *C. didymus*. The hydrocarbons were without significant effect on the flavour of cream or butter. Benzyl cyanide conferred a distinct flavour on dairy products, as did benzyl *iso*thiocyanate, which McDowall *et al.*[1] have shown to occur in the plant. Neither of these compounds reproduced the burnt flavour so characteristic of the taint caused by *C. didymus*. This was traced to a relatively minor constituent of the essential oil, benzyl mercaptan, which was isolated from partially decomposed *C. didymus*, while benzyl disulphide was present to the extent of about 5 per cent in the essential oil of the fresh plant. The taint has been detected when the concentration in butter is as low as 1 part in a hundred million, well below the threshold of

possible chemical detection. This serious dairy problem thus provides another instance of the notorious tainting capacity of mercaptans.

D. A. Forss

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Commonwealth Scientific and
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Dec. 1.

[1] McDowall, F. H., Morton, I. D., and McDowell, A. K. R., *N.Z. J. Sci. Tech.*, **28**, A. 305 (1947).

Persistence of Benzene Hexachloride as an Insecticide on Lime-washed Surfaces

Hitherto, benzene hexachloride has not been recommended for use on lime-washed surfaces, because it decomposes in lime slurry; it does not do so in slurries of chalk or ground limestone. Thus there was reason for believing that exposure to air would eventually make a freshly lime-washed surface suitable for spraying and, as the problem was of practical importance, the following experiment was made to settle the matter.

Porous earthenware surfaces were whitewashed with slurries freshly prepared from quicklime or whiting, aired for 1, 7 and 14 days, and then sprayed with enough benzene hexachloride dispersible powder to leave 7·4 mgm. gamma isomer/sq. ft. At intervals of two, three and four weeks *Sitophilus granarius* adults were exposed on the treated surfaces for two hours, after which they were placed with wheat for mortality counts four days later. The tests were made in triplicate.

Type of whitewash	Days aired before spraying BHC	Percentage mortality of *S. granarius* exposed after 0 to 4 weeks			
		0	2	3	4
Lime	1	98	73	8	4
Whiting	1	91	80	44	31
None	—	93	86	44	33
Lime	7	92	78	29	18
Whiting	7	77	65	40	23
None	—	99	63	23	4
Lime	14	99	41	27	11
Whiting	14	99	54	30	18
None	—	100	75	31	26

Results, given in the accompanying table, show that the deposit on the lime-washed surface lost toxicity relative to that of the other surfaces only after the second week when the airing period was one day. No relative loss occurred on any surface aired for longer periods.

A similar experiment using benzene hexachloride in kerosene yielded much the same results, though insect mortalities were lower, and differences between surfaces tended to be masked owing to absorption of the oil solution by the earthenware.

It is concluded that benzene hexachloride dispersible powder can be sprayed on surfaces seven days after lime-washing without loss of toxicity.

H. H. S. Bovingdon

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Dec. 19.

[1] *J. Sci. Indust. Res.*, **4**, (2), 73 (1945).
[2] *J. Sci. Indust. Res.*, **4**, (8), 493 (1945).
[3] Buhrur, N. E., *Arch. Biol. Tech., Curitiba*, **3**, 61 (1948).
[4] Slade, R., *Chem. Tr. J.*, **116**, (3017), 279 (1945).

A Simple Needle for Micro-Injections

In the course of experiments with injections of viruses into insect vectors, it became desirable to measure the amount of introduced inoculum. The conditions of the experiments demanded an instrument that would fulfil the following requirements: (*a*) to measure accurately the small amounts (approximately 1/8,000 c.c.) of liquid introduced into a single insect; and (*b*) to provide a means of introducing the inoculum into the small insects (leafhoppers) without excessive injury. The first condition could be fulfilled with many of the micro-injecting devices now on the market, or with the modified instrument described by Woodrow[1]. The use of any of these was complicated by the relatively large diameter of the injection needles. The problem was solved by drawing 'Pyrex' micropipettes similar to those ordinarily used for micromanipulation. These pipettes were sealed to hypodermic needles of 25 or 26 gauge. The glass and metal were cemented together with a paste made of glycerine and litharge. This simple device may also prove useful for introducing small amounts of fluids into cells.

Karl Maramorosch

Laboratories of the Rockefeller Institute
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Dec. 21.

[1] Woodrow, A. W., *Science*, **110**, 142 (1949).

William Higgins and John Dalton

Prof. J. R. Partington[1] has disputed the claim I made in my book, "The Story of Atomic Energy"[2], that William Higgins and not John Dalton was the originator of the modern atomic theory, to which Prof. F. A. Paneth[3], in reviewing the book, had directed attention. However, Prof. Partington omitted to mention what I had stated to be Higgins's main claim to fame and ten times more interesting than anything Dalton did. Hence, I trust readers of *Nature* will consider this fresh evidence before making up their minds on the issue.

Briefly, this was that Higgins, by experiments and reasoning which were strangely modern, correctly deduced without any further assumption whatever that if the chemical formulæ of water and sulphur dioxide, respectively, were taken as HO and SO, that of sulphuretted hydrogen was HS_2. Since the two assumed formulæ make, with O = 16, the atomic weights of hydrogen 2 and of sulphur 16, to modernize them the number of hydrogen atoms must be doubled and of sulphur halved, giving correctly, H_2O, SO_2 and H_2S.

Perhaps Prof. Partington will explain how he could have done this without taking into account the weight of the atoms or (except for SO) on the view he imputes to him that the weights of different atoms were the same. I suggest that historians of chemistry who have read Higgins's 1789 book should read it again, and that Daltonians in general who have not read that book (or mine) should try to do in 1951 what Higgins had done in 1789, Avogadro barred.

Before Richter's "Elements of Stöchiometry" (1792–94) had given us the idea of chemical equivalents, before the Proust–Berthollet controversy which began in 1799 had established the constancy of the

weight composition of chemical compounds and the first law of chemical change, Higgins, in addition to having anticipated the second law of multiple proportions and the chemical notation introduced by Berzelius, as is now admitted, had shown that if the relative numbers of atoms in binary compounds of elements A and B and of B and C were assumed, then that of a binary compound of A and C can be found with no further assumption whatever.

Historically interesting, no doubt, as is what William owed to his uncle Bryan, it does not affect the fact that they both wrote in the eighteenth century, whereas Dalton wrote in the nineteenth. Whether Dalton ever read Higgins's book or not he can scarcely be acquitted of mental dishonesty, since it ran, according to Prof. Partington, into two editions, and he could not have been ignorant of the fact that Davy was originally sceptical of his own claims and in 1809 had claimed priority for Higgins[4].

On this side of Dalton's character Prof. Paneth has directed my attention to Ostwald's biography of Dalton[5], in which he blames him for not mentioning in his paper on Northern Lights that their relation to magnetism had been described before by Celsius and others, and for declaring that he did not care what others said as only his own observations were trustworthy. According to this biographer, Dalton over-estimated his own achievements. The idea of atomic weight was a by-product of his work on gases and vapours, and he was unable to do much more than give it birth. What he himself further contributed hampered rather than helped its development, and he left to his contemporaries and successors the real issues. With this masterly summing up many who are familiar with Dalton's life-work will no doubt agree.

Prof. Paneth has also pointed out that, by bringing in the view of Prof. Meldrum that "nothing could be more unlike" the atomic theory even as early as 1860 than that of Dalton and Higgins, Prof. Partington contradicts himself. For as late as 1948 he said[6]: "the later extensions have deepened and broadened its content but in its main outlines it remains Dalton's theory". In this connexion he says it is not clear what I mean by saying Higgins and Dalton are responsible for the modern atomic theory. My views appear in the historical introduction of my book; I can summarize them here and also my view of Lavoisier's Theory of Combustion, which he says is not what it has been made out to be.

I wrote that the historians of chemistry had hopelessly misjudged the phlogistonists, who anticipated the law of the conservation of energy *before* that of mass had been established. I gave Lavoisier, who like Dalton was ungenerous towards others and their work, the chief credit for the emergence of the, now completely separated, atomic and molecular theories, by the establishment of the weightlessness of phlogiston, or energy, which he called the fire-material, and in the next century was renamed 'caloric'. His views on the combustion, in contradistinction to the oxidation, aspect of combustion were identical with those of the phlogistonists, being, in fact, more specific and definite. All this is certainly different from what has hitherto been taught.

Higgins, I consider, in addition to recognizing the Law of Multiple Proportions, and being the first to use chemical symbols, clearly anticipated the methods both of experiment and reasoning by which true atomic weights were ultimately established and therefore deserves the title of originator of the modern atomic theory. It is quite unreasonable to expect of him in the eighteenth century to have given the importance to the relative weight of the atoms which it assumed in the nineteenth after the work of Richter and Proust. As a chemist, he was interested rather in their relative chemical affinities, whereas Dalton as a physicist, like Lavoisier, was mainly interested in their relative weights. Dalton's homely type of mind certainly did yeoman service to the theory in directing the attention of his contemporaries to this in a manner they were capable of understanding. But beyond his Law of Partial Pressures, he contributed little or nothing of any value either to the molecular or the atomic theories. It was Gay Lussac and Avogadro who founded the molecular theory. It was Berzelius who first gave us a table of real relative atomic weights, those of Dalton having been arbitrarily disguised chemical equivalents.

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March 7.

[1] Partington, J. R., *Nature*, **167**, 120 (1951).
[2] Soddy, F., "The Story of Atomic Energy" (Nova Atlantis Publishing Co., 1949).
[3] Paneth, F. A., *Nature*, **166**, 799 (1950).
[4] von Meyer, Ernst, "A History of Chemistry", 184 (English trans., Macmillan and Co., London, 1891).
[5] Ostwald, Wilhelm, in G. Bugge's "Buch der grosser Chemiker", **1**, 378 (Berlin, 1929).
[6] Partington, J. R., *Endeavour*, **7**, 54 (1948).

HIGGINS says several times that sulphuretted hydrogen is "a mere solution" or "suspension" of sulphur in hydrogen, and once that it contains nine particles of sulphur to five of hydrogen (pp. 78–81 of Higgins's book; the experimental results and the argument lead to the ratio nine particles of sulphur to five of hydrogen without any assumption about the weights of the atoms. The argument would occupy half a page of *Nature*). The idea and name of 'equivalent' were published by Cavendish in 1766 and 1788. I think Higgins deserves some credit for the Law of Multiple Proportions; but Berzelius said he did not state it and did not anticipate Dalton. Higgins's symbols did not anticipate Berzelius's; the letters do not always stand for elements and the same letter stands for different substances. Dalton put forward his theory in 1803 and gave a full account of it to Thomson in 1804, and what Davy said in 1809 seems irrelevant.

Dalton's account of the aurora borealis is contained in his book "Meteorological Essays and Observations" (1793), not in a paper, and in the preface he mentions that, after the book was printed, he found that he was anticipated by Halley (1716), who wrote some time before Celsius. Ostwald's article includes some other errors, which are not unusual in the book containing it, but not the remarks attributed to Dalton. After Dalton published his atomic theory, he published important work on the incomplete combustion of hydrocarbons and on the volumes of solutions, and his paper (1837) on the constant composition of the atmosphere up to 15,000 ft. and his explanation in terms of mixing by air currents is noteworthy.

Dalton assumed that the atom of every element has a characteristic weight, that the relative weights can be found experimentally, and that compounds are formed from definite numbers of atoms of the elements. These are still the foundations of the

modern atomic theory. He also assumed that atoms are surrounded by spherical envelopes of heat, like atoms repel and unlike atoms attract, elementary gases are monatomic, binary compounds are formed by preference because of the repulsion of like atoms, equal volumes of gases contain unequal numbers of particles, etc. These assumptions had been abandoned by 1860. I am not conscious of having contradicted myself.

The similarity between the functions of phlogiston and caloric (a name introduced in 1788, not in the nineteenth century) was mentioned in my "Short History of Chemistry" (1937) and is fully described in a paper by Dr. McKie and myself, referred to in my first letter and published ten years before Prof. Soddy's book.

J. R. Partington

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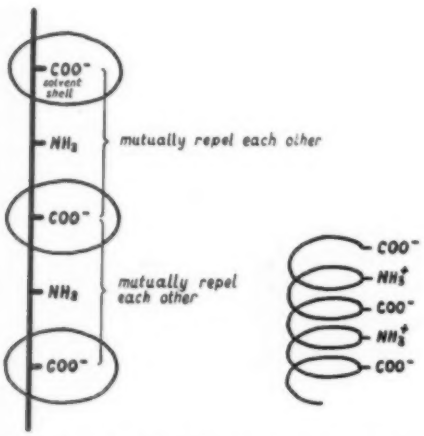
Biological Significance of Folding and Unfolding of Protein Molecules

In an interesting paper which appeared recently in *Nature*, Goldacre and Lorch[1] put forward the hypothesis that folding and unfolding of protein chains plays a decisive part in amœboid movement and cytoplasmic streaming. The same hypothesis was put forward more than twenty years ago by us in connexion with a new theory of muscular contraction[2]. This theory said that the contraction is due to a folding of unfolded protein chains under the influence of chemical reactions, and as one of the possibilities a variation of *p*H was considered; this was illustrated in 1929 by the accompanying diagram.



Protein chains in an alkaline medium (left) and at the isoelectric point (right). From Meyer, K. H., *Biochem. Z.*, **214**, 253 (1929)

Summarizing this hypothesis in our monograph[3], we wrote: "Beim Muskel war es verhältnismässig deutlich zu erkennen, dass die Formänderung von Eiweissketten eine wichtige Rolle spielt. Es liegen nun Anzeichen für ähnliche Vorgänge auch bei Protoplasmabewegungen vor. Hier sind es besonders die Erscheinungen der Doppelbrechung, wie man sie bei Pseudopodien beobachten kann, die darauf hinweisen, dass auch hier Hauptvalenzketten bald zur Streckung und Parallelrichtung, bald zur Kontraktion gebracht werden. Es ist nicht daran zu zweifeln, dass ein weiteres Studium der Form und des Wasserbindungsvermögens der Eiweiss- und Pektinstoffe in ihrer Abhängigkeit vom Medium auch andere physiologische Fragen neu beleuchten wird. Der Turgor der Gewebe, die Resorptions- und Sekretionsvorgänge werden sich dann wohl in ähnliche Beziehungen zum molekularen Geschehen bringen lassen, wie es hier für die Bewegungsvorgänge versucht worden ist."

All these conclusions originated in our work on the molecular structure of silk[4], tendon[2] and muscle[2]. In contrast to the compact 'globular' proteins investigated shortly before by Svedberg[5], we showed for the first time in the substances mentioned the existence of 'fibrillar'-proteins. We were also the first to demonstrate the reversible folding and unfolding of these protein chains[2] provoked by physical or chemical influences, and emphasized that the decrease of viscosity of gelatin which is observed when approaching the isoelectric point is due to a coiling or folding of chains which previously were extended by the repelling force of their electrically charged groups[3].

Although the accompanying diagram is certainly much too simple to account for the phenomena of muscular contraction, we believe that the main principle of our theory, namely, folding and unfolding of myosin chains governed by chemical reactions, will form the basis of any future theory.

Concluding their paper, Goldacre and Lorch say: "The protein molecule is unique in that its chemical and physical properties are greatly altered by changes in the degree of folding of the polypeptide chain. That this property might be exploited in living cells and be the basis of many vital phenomena has been suggested, especially by Astbury and Szent-Györgyi." The work of these authors is, however, of much later date than ours.

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Feb. 13.

[1] Goldacre, R. J., and Lorch, I. J., *Nature*, **166**, 497 (1950).
[2] Meyer, K. H., *Biochem. Z.*, **214**, 253 (1929).
[3] Meyer, K. H., and Mark, H., "Der Aufbau der hochpolymeren organischen Naturstoffe auf Grund molekular-morphologischer Betrachtungen", 232, 243 (Leipzig, 1930).
[4] Meyer, K. H., and Mark, H., *Ber. dtsch. chem. Ges.*, **61**, 1932 (1928).
[5] Svedberg, T., and Fåhraeus, R., *J. Amer. Chem. Soc.*, **48**, 430 (1926). Svedberg, T., and Nichols, J. B., *J. Amer. Chem. Soc.*, **48**, 3081 (1926).

In a necessarily short article the mention of one or two of the more recent summaries was not intended to be exclusive; but we naturally regret it if we failed to do proper justice to the early and important contributions to the subject made by Prof. Meyer and Prof. Mark.

R. J. Goldacre
I. J. Lorch

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 7

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Fifth Annual General Meeting; Prof. J. R. Partington: Presidential Address.

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. W. Russell: "On the Comparative Study of Behaviour".*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Brigadier M. Hotine: "The Background of British Colonial Development".

Tuesday, May 8

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Messrs. G. T. Meiklejohn and R. C. Snell: "Economic Reactor Design".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Luminescence".

Wednesday, May 9

ROYAL SOCIETY OF ARTS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Prof. R. G. W. Norrish, F.R.S.: "Lyon Playfair, and his Work for the Great Exhibition of 1851" (Pope Memorial Lecture).

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 4 p.m.—Symposium on "Combustion Reactions in relation to Gas Turbine Practice".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Symposium on "The Sutton Coldfield Television Station".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Dr. W. F. J. Cuthbertson: "Antibiotics in Nutrition".

Thursday, May 10

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Papers on "Diffraction Gratings".

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. R. M. Titmuss: "Social Administration in a Changing Society" (Inaugural Lecture).*

CHEMICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7.30 p.m.—Prof. H. W. Melville, F.R.S.: "Transient Entities in Chemical Reactions" (Liversidge Lecture).

UNIVERSITY OF LONDON (in the Swanley Hall, Wye College, Wye, Kent), at 8 p.m.—Prof. S. Zuckerman, F.R.S.: "Monkeys and Agriculture".*

Friday, May 11

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

BEDSON CLUB (in Lecture Theatre I of the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. H. Krebs, F.R.S.: "The Use of Isotope Technique in the Study of Cell Metabolism".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. O. R. Frisch, F.R.S.: "The Artificial Acceleration of Atomic Particles".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN ZOOLOGY, RESEARCH DEMONSTRATORS IN PHYSICS, a LECTURER IN ECONOMIC HISTORY, and an ADMINISTRATIVE ASSISTANT IN THE DEPARTMENT OF ADULT EDUCATION—The Registrar, University College, Leicester (May 10).

INSTRUCTOR IN ENGLISH AND NAVIGATION at the Greek Merchant Navy School, Hydra—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1 (May 10).

ASSISTANT CHEMIST (with University degree in chemistry or equivalent, and some postgraduate experience in general analytical work, research, or works laboratory practice) in the Chief Chemist's Division—The Chief Engineer, Main Drainage Department, Mogden Works, Isleworth, Middx., quoting J.278.T (May 12).

BACTERIOLOGIST (Consultant status) IN THE DEPARTMENT OF BACTERIOLOGY—The House Governor and Secretary, Royal Victoria Infirmary, Newcastle-upon-Tyne (May 12).

SENIOR LECTURER IN AGRICULTURE at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (May 12).

TEACHER (with a degree in mathematics and physics) OF MATHEMATICS AND PHYSICS, and a TEACHER (with a degree in chemistry, botany and zoology) OF CHEMISTRY AND BIOLOGY—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (May 12).

TEACHERS (university graduates) IN MATHEMATICS, BIOLOGY (specialization in zoology preferred), and ENGLISH AND SOCIAL STUDIES, at the Coventry Technical College—The Director of Education, Council House, Coventry (May 12).

DEWAR RESEARCH FELLOWSHIP for investigations in radiochemistry—The Secretary, The University, Edinburgh (May 15).

JUNIOR PROFESSIONAL OFFICER (with an honours degree in agriculture or an equivalent qualification), FIELD HUSBANDRY BRANCH, Department of Research and Specialist Services—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (May 15).

LECTURER OR SENIOR LECTURER IN AERODYNAMICS—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Lecturer in Aerodynamics' (May 15).

PROFESSOR OF MATHEMATICS—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Professor of Mathematics' (May 15).

RESEARCH ASSISTANT (graduate with honours degree in chemistry) in connexion with research under the auspices of the Medical Research Council—Dr. B. Levin, Queen Elizabeth Hospital for Children, Hackney Road, London, E.2 (May 15).

SENIOR LECTURER IN GEOLOGY (with special qualifications in petrology, geophysics or economic geology) in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 15).

SUPERINTENDENT OF AIRWORTHINESS AND AERONAUTICAL ENGINEERING in the Department of Civil Aviation, Commonwealth of Australia—The Australian Civil Aviation Liaison Officer, Australia House, Strand, London, W.C.2 (May 17).

COLLEGE RESEARCH STUDENTSHIPS IN THE DEPARTMENTS OF BOTANY, CHEMISTRY, PHYSICS and ZOOLOGY—The Registrar, University College, Hull (May 19).

RESEARCH ASSISTANT (with a considerable knowledge of physics) IN THE DEPARTMENT OF ANÆSTHETICS—The Secretary, Welsh National School of Medicine, 34 Newport Road, Cardiff (May 19).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (May 21).

ELECTRICAL ENGINEERS and PHYSICISTS (Senior Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.159/51A (May 24).

TELECOMMUNICATIONS ENGINEERS AND PHYSICISTS (Principal Scientific Officer or Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.158/51 (May 24).

LEVERHULME STUDENTSHIPS IN CHEMICAL ENGINEERING—The Registrar, University College, Gower Street, London, W.C.1 (May 26).

PRINCIPAL RESEARCH OFFICER (with university degree, with honours, in botany, with experience in field research in tropical zones), Land Research and Regional Survey Section, Canberra, for agricultural research in the dry-monsoon belt of Northern Australia—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3377 (May 26).

GRADUATE IN AGRICULTURE AND ECONOMICS (or holder of a diploma in agriculture) in the Economics Section of the Department of Agriculture—The Registrar, The University, Leeds 2 (May 28).

ASSISTANT DIRECTOR (Laboratories), duties include assisting in the direction of research in the fields of chemistry and physics, together with some administrative responsibilities (Ref. TT/315), and an ASSISTANT DIRECTOR (Technical Undergrounds), duties include assisting in the direction of research into mining problems, together with some administrative responsibilities (Ref. TT/316), at the Central Research Establishment, Stoke Orchard, near Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (May 29).

INSPECTOR (Salmon and Freshwater Fisheries)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 191/51 (May 29).

DIRECTOR OF THE MUSEUMS AND ART GALLERY—The Town Clerk, Town Hall, Leicester, endorsed 'Director' (May 30).

DEPUTY COAL SURVEY OFFICER (with good honours degree, or equivalent, in chemistry or fuel technology, preferably with industrial experience in laboratory control) at the Coal Survey Laboratory, Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/321 (May 31).

ENTOMOLOGISTS (3) to form a pool from which an entomologist can be detailed or seconded to any Colonial territory to undertake a comparatively short-term investigation of any particular problem as required—The Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7 (May 31).

LECTURER (Grade II) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Secretary, The University, Birmingham 3 (May 31).

PRINCIPAL RESEARCH OFFICERS or SENIOR RESEARCH OFFICERS, Coal Research Section of the Commonwealth Scientific and Industrial Research Organization, Chatswood, New South Wales: (Ref. No. 3345) to investigate the coke-gas-and-by-product-making properties of Australian coals, and to be responsible for the work of the Section dealing with the carbonizing of coal; (Ref. No. 3346) to conduct investigations into the chemistry of coal to assist in the direction of work of technical staff engaged on a comprehensive survey of the chemical properties of coal—The Australian Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 31).

SCHOLARSHIPS IN RUBBER TECHNOLOGY tenable at the National College of Rubber Technology—The Secretary, Institute of Rubber Industry, 12 Whitehall, London, S.W.1 (May 31).

HARWELL SENIOR AND JUNIOR FELLOWSHIPS—The Director, Atomic Energy Research Establishment, Harwell, Didcot, Berks (June 1).

SENIOR LECTURER IN PHYSICAL CHEMISTRY, and a SENIOR LECTURER IN PHYSICS, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 1).

SENIOR LECTURER IN PHYSICS, and a SENIOR LECTURER IN PHYSICAL CHEMISTRY, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 1).

STOTHERT RESEARCH FELLOWSHIPS IN THE FIELD OF MEDICINE, including the sciences on which medical knowledge is based—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 11).

CHAIR OF ZOOLOGY in the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 15).

LOCKE RESEARCH FELLOWSHIP for research in the general field of experimental physiology and pharmacology—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 16).

LECTURER IN ZOOLOGY, and a LECTURER IN BOTANY, at the New England University College (University of Sydney)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 25).

DAVID BROWN SCHOLARSHIP IN AGRICULTURAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (July 14).

HARRY FERGUSON SCHOLARSHIPS IN AGRICULTURAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (July 14).

ASSISTANT FORECASTER (with a university degree, preferably in science, and specialized in meteorology) by the Government of Iraq for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.26338.E.

ASSISTANT LECTURER IN PHYSICS—The Secretary, University College, Southampton.

ASSISTANT PHYSICIST (with an honours degree in physics and at least two years postgraduate experience)—The Medical Superintendent, St. Luke's Hospital, Guildford, Surrey.

BIOCHEMIST (who will also undertake hydrography), and MARINE BIOLOGISTS (2), in the West African Fisheries Research Institute—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

ENGINEER-GEOLOGISTS in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27079/18/51.

INSTRUCTOR IN PHYSIOLOGY at the Hadassah Medical School, Hebrew University, Jerusalem—The Secretary, Friends of the Hebrew University of Jerusalem, 97 Baker Street, London, W.1.

LECTURER IN EXPERIMENTAL PSYCHOLOGY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

PHYSICIST for research on the design and operation of metallurgical furnaces using model techniques—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Furnaces'.

POSTGRADUATE SCHOLARSHIPS IN TEXTILE TECHNOLOGY, TEXTILE ENGINEERING, TEXTILE CHEMISTRY or DYEING—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SENIOR ELECTRICAL ENGINEER (Special Works) for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Senior Electrical Engineer 4/310'.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments, and for a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

TECHNICAL RECORDS OFFICERS (with honours degree in chemistry, Associateship of the R.I.C., or equivalent qualifications) by the Division of Atomic Energy at Springfields Factory, Salwick, Preston, and Windscale Works, Sellafield, Cumberland, to assess raw material requirements, progress supplies and prepare and interpret plant operating data with a view to facilitating production planning and cost control—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry: Meteorological Office. Meteorological Reports No. 8: Upper Air Analysis and Tropical Forecasting. By R. A. S. Ratcliffe. (M.O. 535c.) Pp. ii+18. (London: H.M. Stationery Office, 1950.) 9*d*. net. [161

Telepathy and Human Personality. By Prof. J. B. Rhine. (Tenth Frederic W. H. Myers Memorial Lecture, 1950.) Pp. 39. (London: Society for Psychical Research, 1950.) 1*s*. 6*d*. net. [181

General Register Office. The Registrar General's Quarterly Return for England and Wales—Births, Deaths and Marriages, Infectious Diseases, Weather, Survey of Sickness, Population Estimates, Quarter ended 30th September 1950. Pp. 36. (London: H.M. Stationery Office, 1950.) 1*s*. net. [181

British Standard 903: 1950, Methods of Testing Vulcanized Rubber. Revised edition. Pp. 248. 21*s*. net. British Standard 1677: 1950, Draughtsmen's Drawing Pins. Pp. 6. 1*s*. net. British Standard 1683: 1950, Coated Aluminium Foil for Wrapping Cheese. Pp. 12. 2*s*. net. British Standard 1686: 1950, Long-Period, High-Sensitivity Tensile Creep Testing. Pp. 9. 2*s*. net. British Standard 1687: 1950, Medium-Sensitivity Tensile Creep Testing. Pp. 9. 2*s*. net. British Standard 1688: 1950, Determination of Time to Rupture under Stress. Pp. 9. 2*s*. net. (London: British Standards Institution, 1950.) [181

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 21: The Investigation of Road Foundation Failures. By W. A. Lewis. Pp. vi+23+7 plates. (London: H.M. Stationery Office, 1950.) 1*s*. 6*d*. net. [181

Centenary Proceedings of the Royal Meteorological Society, 1950. Pp. iv+280. (London: Royal Meteorological Society, 1950.) 21*s*. [181

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Technical Paper No. 9: Test Walls for assessing Construction Times with New Building Blocks. By W. Kinniburgh. Pp. iv+8+4 plates. (London: H.M. Stationery Office, 1950.) 9*d*. net. [181

Other Countries

Fieldiana. Zoology, Vol. 31, No. 39: Report on a Collection of Birds from Guerrero, Mexico. By Emmet R. Blake. Pp. 375–394. 25 cents. Zoology, Vol. 31, No. 40: Report on a Collection of Birds from Oaxaca, Mexico. By Emmet R. Blake. Pp. 395–420. 25 cents. (Chicago: Field Museum of Natural History, 1950.) [151

Kementerian Perhubungan, Tenaga dan Pekerdjaran Umum. Djawatan Meteorologi dan Geofisik. Verhandelingen No. 40: On the Distribution of Duration of Sunshine in Java. By Dr. F. H. Schmidt. Pp. 18. (Djakarta: G. Kolff and Co., 1950.) [151

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige undersøgelser i Grønland. Bd. 114, Nr. 10: On the Pre-Cambrian to Cambrian Sedimentation in NE-Greenland. By H. P. Schaub. (De Danske Ekspeditioner til Østgrønland 1936–38). Pp. 50+1 plate. 4.50 kr. Bd. 143, Nr. 1: Report on the Expeditions to Central East Greenland 1926–39 conducted by Lauge Koch, Part 1. Notes on some Topographical and Geological Maps of East Greenland. By Lauge Koch. (De Danske Ekspeditioner til Østgrønland 1926–39). Pp. 11+7 plates. 25 kr. Bd. 147, Nr. 6: Chromosome Numbers of some Arctic or Boreal Flowering Plants. By Tyge W. Böcher and Kai Larsen. (Den Botaniske Ekspedition til Vestgrønland 1946). Pp. 32. 2.50 kr. Bd. 147, Nr. 7: Contributions to the Flora and Plant Geography of West Greenland, 2, The *Carex capitata*, the *Luzula multiflora*, and the *Torularia humilis* Complexes. By Tyge W. Böcher. (Den Botaniske Ekspedition til Vestgrønland 1946). Pp. 39+5 plates. 4 kr. Bd. 150, Nr. 6: The Marine Mammals and the Marine Fauna in the Thule District (Northwest Greenland), with Observations on Ice Conditions in 1939–41. By Christian Vibe. (Den Danske Thule or Ellesmere Land Ekspedition 1939–41). Pp. 116. 8.75 kr. Bd. 151, Nr. 2: The Polychaeta of West Greenland, with special reference to the Fauna of Nordre Strømfjord, Kvane- and Bredefjord. By Elise Wesenberg-Lund. Pp. 171+78 charts. 14 kr. Bd. 151, Nr. 3: Geologisch-petrographische Untersuchungen in der Innern Fjordregion des Kejser Franz Josephs Fjordsystems in Nordostgrönland. Von Walter Huber. (De Danske Ekspeditioner til Østgrønland 1947–51). Pp. 84+1 plate. 6.50 kr. (København: C. A. Reitzels Forlag, 1950.) [161

Yale University School of Medicine. Tenth Annual Report of the Historical Library, 1949–50. Pp. 40. (New Haven, Conn.: Yale University, 1950.) [161

World Health Organization. Technical Report Series No. 22: Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel; Report on the First Session. Pp. 36. (Geneva: World Health Organization; London: H.M. Stationery Office, 1950.) 2*s*.; 25 cents. [161

Union of South Africa: Department of Education, Arts and Science. Report of the Archaeological Survey of the Union of South Africa for the Period 1st April 1948 to 31st March 1949. (Annual Report No. 14). Pp. 8. (Pretoria: Government Printer, 1950.) [161

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 2: July–December 1949. Pp. ii+88. (Delhi: Unesco Science Co-operation Office for South Asia, 1950.) [161

Catalogues

Murex Review. Vol. 1, No. 7. Pp. 125–164. (Rainham: Murex, Ltd., 1950.)

G.E.C. Cold Pressure Welding particularly as Applied to Aluminium. Second edition, revised. Pp. 16. (London: General Electric Co., Ltd., 1950.)

Metropolitan-Vickers Gazette. Vol. 23, No. 383, January 1951. Pp. 273–296+viii. (Manchester: Metropolitan-Vickers Electrical Co., Ltd., 1951.)

Cambridge Thermographs. (Folder 65A). Pp. 6. (London: Cambridge Instrument Co., Ltd., 1951.)

Progress. Vol. 41, No. 229, Winter 1950–51. Pp. 48. (London: Lever Brothers and Unilever, Ltd., 1951.)

Electrostatic Voltmeters. (Sheet 153). Pp. 2. Master Frequency Meters. (Sheet 197). Pp. 2. (London: Everett Edgcumbe and Co., Ltd., 1951.)

Light's Organic Chemicals. New edition. Pp. 32. (Colnbrook: L. Light and Co., Ltd., 1951.)

Grid Controlled Rectifiers and Motors for Variable Speed Drives. By V. W. Press. (M.L.70). Pp. 8. (Manchester: Lancashire Dynamo and Crypto; London: L.D.C. Group Publicity, 25 Shaftesbury Avenue, W.1, 1951.)

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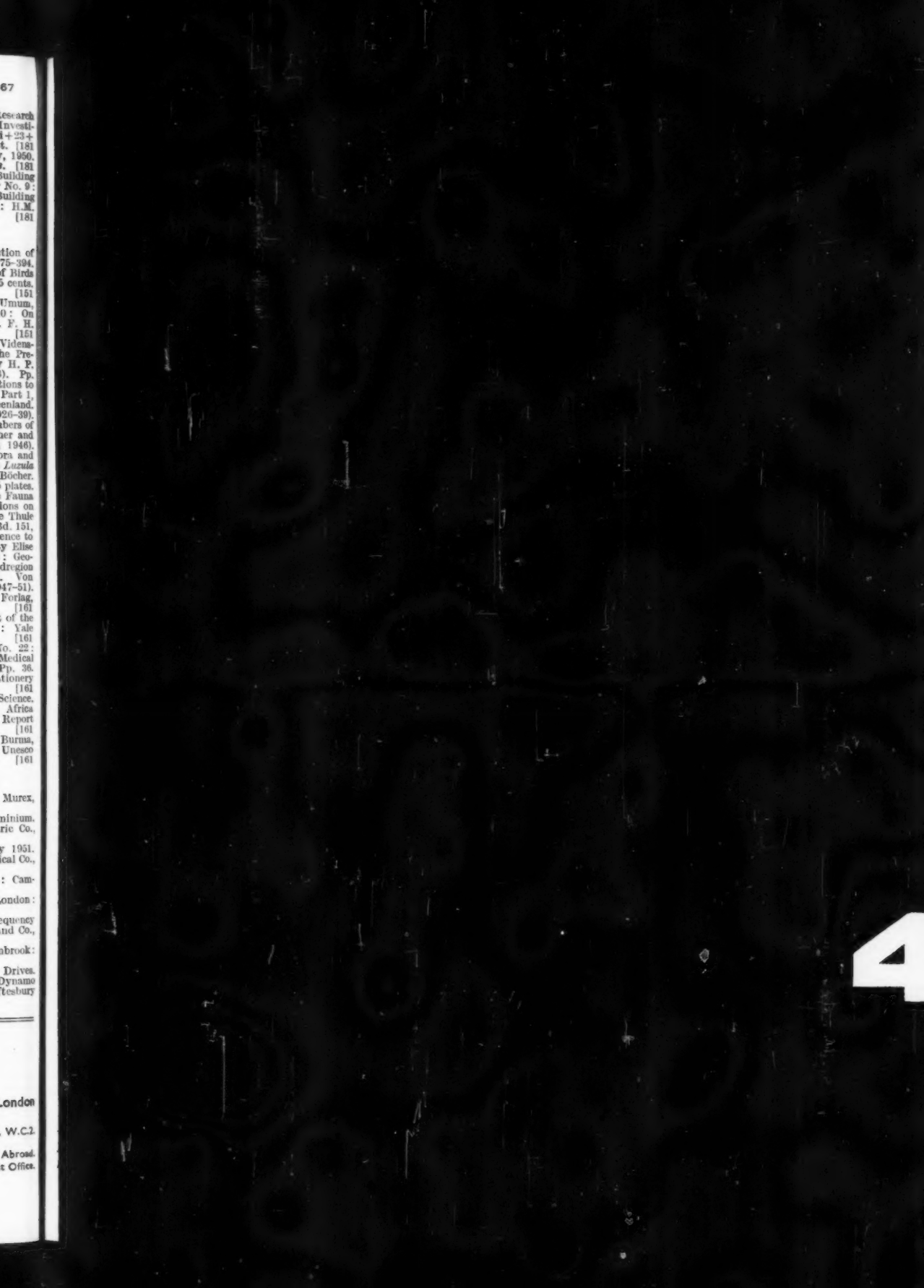
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